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TO THE

EXECUTIVE DOCUMENTS

OF THE

HOUSE OF REPRESENTATIVES

FOR THE

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1881-'82.

IN 26 VOLUMES.

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WASHINGTON:
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47TH CONGRESS, 1st Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 228.

REPORT

OF THE

COMMISSIONER OF AGRICULTURE

FOR

THE YEARS 1881 AND 1882.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1882.

JOINT RESOLUTION providing for printing the Annual Report of the Commissioner of Agriculture for eighteen hundred and eighty-one.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed three hundred thousand copies of the Annual Report of the Commissioner of Agriculture for the year eighteen hundred and eighty-one; two hundred and fourteen thousand copies for use of members of the House of Representatives, fifty-six thousand for the use of members of the Senate, and thirty thousand copies for the use of the Department of Agriculture; and two hundred and nineteen thousand one hundred and sixty-one dollars and fifty-four cents, or so much thereof as may be necessary, is hereby appropriated out of any money in the Treasury not otherwise appropriated to carry out this joint resolution.

Approved, August 8, 1882.

JOINT RESOLUTION relative to the printing of the annual reports of the Commissioner of Agriculture for the years eighteen hundred and eighty-one and eighteen hundred and eighty-two.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the appropriation made by the joint resolution of Congress approved August eight, eighteen hundred and eighty-two (22 Stats., 35395) providing for printing the annual report of the Commissioner of Agriculture for eighteen hundred and eighty-one, shall and may be used for the printing in one volume of the reports of the Commissioner of Agriculture for the years eighteen hundred and eighty-one and eighteen hundred and eighty-two.

Approved, December 12, 1882.

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REPORT

OF THE

COMMISSIONER OF AGRICULTURE.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., November 25, 1881.

TO THE PRESIDENT:

I respectfully submit the annual report of the Department of Agriculture for the year 1881.

When I entered upon my duties as Commissioner, July 1 of the current year, I found the work for the season, both regular and special, elaborately laid out by my predecessor. Provision had been made for investigating the agricultural condition of the Pacific coast; for continuing the work on the artesian well in Colorado; for proceeding with the experiment in the cultivation of the tea plant; for concluding the investigation into the manufacture of sugar from sorghum; for observations on the existence of pluro-pneumonia and other contagious diseases of animals, both in this country and in those English ports to which American cattle are exported; for continued examinations into the necessities and opportunities of American forestry; for tests of textile fibers, both animal and vegetable; for a scientific investigation of the habits of insects injurious to vegetation, and of the best methods of destroying them; and for the usual work of the various divisions of the department for which appropriations had been made by Congress.

I have endeavored to conduct all experiments in which I found the department engaged, with an ardent desire to bring them to legitimate conclusions, in the spirit of an investigator and not in the spirit of an advocate.

The process of manufacturing sugar from sorghum has been conducted by the best skill I could obtain in the country, under the eye of experienced chemists, and with ample and somewhat expensive machinery, run by an accomplished and faithful engineer.

The crop was gathered with the greatest possible economy of time, labor, and expense, and the work was carried on with as much expedition as the season would allow. The result of this work will be found under the appropriate head of this communication and in the elaborate report of the chemist of the department.

The expenses of the attempt to cultivate the tea plant in South Carolina have been somewhat curtailed, without, however, interfering with the proposed experiment. In the management of this enterprise, I have been governed largely by the opinions of the accomplished and experienced horticulturist of the department, Mr. Saunders, and by a proper regard for economy in the expenditure of the money appropriated for this purpose.

A thoroughly scientific and practical commission, appointed with great care and provided with instructions obtained from Major Powell, has examined the artesian well now in process of construction, and has explored, under the rules of structural geology, a large portion of the arid regions in which these wells may be valuable.

A veterinary surgeon has been sent to England to confer with the Privy Council upon the exact condition of American cattle landed in her markets; and agents and experts have been employed to ascertain all facts relating to the existence of contagious diseases in this country, in accordance with appropriations for this purpose. And while these various commissions and agents have been employed in prosecuting the work assigned them, the work of the various divisions of the department has been prosecuted with diligence and fidelity by those into whose hands it has been committed.

During the last three months I have considered it my duty to visit various important agricultural sections of the country on occasions where I could not only witness the exhibited results of the farmers' industry, but could also obtain an opinion of the general condition of agriculture and the popular expectations of the department. I have been especially desirous of ascertaining the sources whence the department obtained its statistics and crop returns, and the estimate put upon these reports by those interested in them.

It seemed to me important to learn how far the distribution of seed by the department had improved our old crops and introduced new ones. I have been anxious to learn what breed of domesticated animals had been introduced wisely and increased judiciously and profitably, with due regard to quality and market. For these observations, I have visited New England, Illinois, Wisconsin, Pennsylvania, Virginia, South Carolina, Maryland, and Georgia, and have been liberally furnished with all possible means for pursuing my work.

That the American soil is producing vast crops, at the hands of diligent and intelligent cultivators, the returns of the markets constantly bear witness; and I can add my own testimony to the energy and skill with which this work is performed, even under the discouragements of drought and flood and frost. I have found the agricultural mind of the country active in its desire to obtain the best knowledge, and to examine and test all the best methods; and I have been especially impressed with the vast opportunities which this department possesses for aiding the development of our vast resources, and for accumulating and distributing information upon that great cluster of industries upon the successful prosecution of which the prosperity and power of our country depends. That in agriculture we have still great room for improvement every one must be aware who realizes that a large proportion of our staple crops is as yet, as it were, a spontaneous production of the earth, and that exhausted soils are abandoned for more fertile regions as the best method of farming.

That our manufacturers have but just commenced their career (important as they are) must be evident to him who remembers that fifty years ago they had hardly an existence, and that a producing and consuming population increases here at the rate of a million or more a year. That much may yet be done to systematize and organize the producing and transporting business of our country no one can doubt who has studied, even carelessly, these great economic questions. And I am confident that an enlarged and well endowed and well arranged department, devoted to industrial investigations, will commend itself to those who are engaged in the work of legislation, upon which the policy and practical operation of our government depend.

By surveys of the great unexplored mineral wealth of the southern slopes of the Alleghanies; by more careful examination of the farming lands of the government; by supplying recorded data of our manufacturing and mechanical productions; by obtaining more accurate knowledge of our agricultural resources and capabilities; by securing all the possible fruits of industrial education, and recording all the conditions of labor; by pursuing our scientific investigations, in which the Agricultural Department has been so long engaged, with increased zeal and endowment, the Government of the United States may take its stand among the most enterprising and prosperous of those nations in which departments are provided and supported for every purpose which can possibly increase the national wealth and intelligence and stimulate the national enterprise.

In setting forth these views, I do not overestimate the value and importance of a department devoted to agriculture and the industries that stand around it and depend upon it for existence, nor do I exaggerate the picture of that organization which will ultimately be established in accordance with the legislative wisdom of the land, guided by the demands of an intelligent and prosperous people, who will spare no effort to make this country equally distinguished for prosperity and that cultivation which always attends the march of industry.

For the purpose of bringing the department into immediate conference with the various institutions organized to develop the agriculture of the country, I have called delegate conventions, composed of representatives of the State societies and the colleges founded on the land grant of Congress, to meet at Washington in January next, and have assigned to each convention one of the following topics for consideration, viz: Agricultural education, as promoted by societies and conveyed by colleges; Animal Industry; Horticulture; Cereals and Grasses. I have also called a convention of cotton planters, which met at Atlanta November 2, in connection with the admirable industrial exposition there, and considered the cotton culture and general agriculture of the cotton States. During my visit to Atlanta my attention was called to a most remarkable exhibit of the crops, woods, mineral products, &c., of a section of our country south of the latitude of Washington, furnished by many railroads in that section, as an illustration of the resources which abound there. I have not seen in this country a more valuable representative and illustrative exhibition of our natural wealth, and, impressed with the idea that the examination of these products would impress the mind of all, native and foreign, who might see them, I have requested the parties having them in charge to bestow them upon the Agricultural Department for proper arrangement and public observation. I am happy to say that several of the roads which have made the collections have complied with my request, and I hope to be able to exhibit in the department this most important display of some portions of that industry, to develop which the department itself was organized.

Of the work of the various divisions in the department, I submit the following concise statements:

DIVISION OF GARDENS AND GROUNDS.

The distributions during the year have embraced over 100,000 plants of various kinds. Large quantities of the hardiest varieties of the foreign grape have been sent to Texas, Florida, and others of the Southern States, with good promise of success.

The distribution of tea plants has also been continued, and preparations are in progress for a more liberal supply of tea seeds, so that the efforts to further the intruduction of this important crop may be maintained.

The purposes of the experimental grounds can never be fully realized until facilities are secured for extending the work in various suitable localities. The department is constantly subject to demands from California, Florida, and similar climatic sections for plants of semi-tropical countries. The most important, perhaps, of these requests are those for oranges and lemons, and for other species of the citrus family. In the climate of Washington the propagation of semi-tropical plants is necessarily confined to glass structures; and although several thousands are annually produced, the number is totally inadequate to meet the wants of correspondents or make an impression upon the progress of this branch of culture. With a propagating establishment in an orange-growing climate, operations could be conducted on an extensive scale, similar to that practiced in regard to peaches, apples, and other hardy fruit trees in the Northern States, and to an extent more in accordance with the requirements of the country.

Propagation would not be confined to the orange family; many other semi-tropical plants require attention. The pine-apple, banana, guava, chocolate, cinnamon, coffee, tea, pepper, ginger, arrowroot, and many fiber-producing and starch-yielding plants might be mentioned as being altogether worthy of careful experimental culture or for propagation.

But the value of such an establishment is not confined to the propagation of plants only. There are numerous questions of much moment which can be answered only from the results of well-directed and closely-conducted tests. The facts, as well as the principles involved in the systematic rotatation of crops, rest in comparative obscurity; but little is known about it, except that it is a practice absolutely essential to profitable culture. The same remarks apply in regard to the value of changing seeds from one soil and climate to another soil and climate. It is well known that results follow such changes, sometimes favorably and sometimes unfavorably; but how far these are influenced by soil alone, by climate alone, or their combination, has not reached a decision of practical applicability.

All of our cultivated plants have run into numerous varieties, many of them comparatively worthless, and many others of local value only, or of limited special utility; it is therefore a matter of much importance to acquire a thorough and exact knowledge, as far as practicable, of their respective values, and this can only be secured by comparative tests where all are cultivated under similar conditions in similar climates.

The results of such tests will also indicate the line of operations to be pursued in improving by crossing or by hybridizing varieties combining special values; this is a most important work, and if properly conducted cannot fail in reaching results of great value. But to reach these results will require several operative points, carefully selected so as to embrace distinct regions for purposes of interchange of crops, &c.

The subject is one of immense importance and might be elaborated in extensive detail. What has been said above merely outlines some of the work which may occupy attention on experimental grounds.

BOTANICAL DIVISION.

During the year past the botanist has continued the work of his division as thoroughly as circumstances would permit.

His attention has been largely employed in the necessary investigations for the proper classification of the plants in the herbarium.

Extensive additions have been made during the year, chiefly of plants from California and the Western Territories. A valuable collection of the plants of Southeastern Texas and the adjacent parts of Mexico has also been procured.

These plants, however, still remain in the original packages, on account of the withdrawal of the customary assistance which has been employed in the preparation and mounting of the specimens.

The work of describing and delineating grasses for the annual report has been continued. More extended and practical results might be anticipated with respect of the cultivation of our native grasses, by observations and investigations in the field, which are not at present provided for.

During the past two or three years botanical investigation in different parts of our country, and especially in the new States and Territories, has been unusually active; many new species have been discovered and a better knowledge of many others has been obtained. All that is valuable in the collection of these investigators should be procured at the earliest opportunity and added to the herbarium, in order that the department may have the means of answering any inquiries respecting the vegetable productions of the country.

The herbarium contains a representation of about nine-tenths of all the plants at present known as natives. A portion of this number, however, are imperfect specimens, which require replacement as soon as good and characteristic specimens can be procured.

The value of the herbarium is not limited to its uses in connection with this department. Inquiries sometimes occur from the Patent Office and other departments relative to plants which have medicinal or economic properties. Within a few years a considerable number of California plants have gradually assumed importance as standard medical remedies, and others for various economic properties, and it is certain that as our vegetation becomes better known still other valuable additions to the arts and sciences will be obtained from that source.

MICROSCOPICAL DIVISION.

During the past year the microscopist has made many investigations relating to plant and animal diseases, with a view of providing remedies. Fruits, vegetables, and food adulteration, including butter and oleomargarine, milk, "poisoned cheese," diseases of wheat, orange-tree rust, pear-leaf rust, yellows of peach, and diseases of the foliage of various trees, have engaged his attention. He has also made many specimens of microscopical slides, illustrating animal diseases. He has discovered new and effectual methods of distinguishing the fats of various animals and vegetables from each other promptly and decisively, by which means butter and oleomargarine are distinguished at once from each other.

For several years past many correspondents have urged upon the department the necessity of publishing information on the edible mushroom of the United States. To this end the microscopist has prepared for publication a series of twelve typical plates in natural colors, with a full and instructive statement of their character, habits, and habitats, together with the most reliable and improved methods of preparing mushrooms for the table.

His microscopical investigations have also comprised the search for trichinæ in the swine flesh of the Washington markets—an animal parasite found in the muscles of animals, and sometimes in man, producing death by its presence—but in no case has a trace of their presence been found in the flesh of swine sold in this city, although found in specimens sent from distant parts for microscopical investigation.

Microscopical investigations have also been made for other divisions of this department.

CHEMICAL DIVISION.

Since the completion of the work reported in the annual report of the department for the year 1880, the following investigations and analyses have been accomplished in the chemical division:

Analyses of 57 marls, 47 ores, &c., 2 mineral waters, 9 soils, 11 fertilizers, 1 medicinal plant, 4 sumacs for tannin, and 9 miscellaneous analyses, making in all 140.

Besides the above, there have been made 1,858 analyses of saccharine juices, sirups, and sugars; the greater part of these being the expressed juices from thirty-eight varieties of sorghum, and eight varieties of maize, grown upon the department grounds.

A portion of the force of the division has been occupied in making sirup on a small scale from sorghum and maize, and a report of these operations, together with the report of the numerous analyses of the cane juices, carried on in the laboratory, will be submitted as soon as it is possible to complete final averages, tabular statements, &c., which work is being prosecuted as rapidly as is possible with the force engaged.

Several other investigations of much importance are in progress, among which may be mentioned the analyses of grasses and various feeding materials, which are being carried out with a view to determine, as accurately as possible by the modes of analysis at present in use, the actual nutritive value of all the agricultural food-materials in the different conditions in which they are sold and fed. For this purpose, a large and representative collection of samples has been made and carefully prepared for analysis.

Again, extensive work on the question of analysis of commercial fertilizers is progressing. The importance of the adoption of a uniform method of fertilizer analysis by all the official chemists of the country can scarcely be overestimated. The subject has already occupied nearly the entire time of three conventions of agricultural chemists, held in Washington and Boston in 1880, and in Cincinnati in 1881. The method adopted at the latter meeting, and at present in use, is only provisional.

Among other subjects that have been awaiting attention, is an examination of certain lands which injuriously affect the growth of the cotton plant and orange tree. The same has been earnestly requested of the department for a long time, as has, also, a series of exhaustive analyses of our cereals, more especially of corn and wheat, connected in the latter case with experiments as to their milling properties and the bread-making qualities of the flour obtained therefrom.

ENTOMOLOGICAL DIVISION.

The principal work of the past year in this division has been in relation to the scale-insects or bark lice (family *Coccidae*) which so seriously affect most kinds of fruit trees. It grew out of the special investigation of the insects affecting the orange begun by Professor Riley in 1878, as it was found that the chief enemies of citrus fruits were scale-insects. So little attention had been given to this family in the United States, however, that the investigations naturally broadened so as to include all scale-insects affecting cultivated plants, and the forthcoming report of the entomologist for the year 1880 is chiefly devoted to the consideration of these insects. It contains a general review of their characters; important discoveries as to their habits and mode of development; a consideration of the most available means of destroying them; a special report on the parasitic checks; and descriptions of many new species. Various other insects of economic importance are likewise treated of in that report, especially such as affect the sugar-cane and corn.

The increased appropriation given to this division by the last Congress has afforded the means for greater activity in the more practical field work of the division, and special agents are engaged thereat in various parts of the country. Particular attention is being paid to the insects injuriously affecting the chief staples, as corn, wheat, rice, sugarcane, and also to those affecting fruit trees and vegetables.

The United States Entomological Commission, which has done excellent work under the Interior Department, is, by late action of Congress, now connected with this department—a connection eminently appropriate. The commission is at work on its third report; a revised and enlarged edition of Professor Riley's report on the cotton worm is also being prepared, and a bulletin on forest-tree insects by Dr. Packard is in press and nearly ready for distribution.

The special investigation of the insects affecting the cotton crop is being actively carried on, particularly in its more practical bearings, and most valuable discoveries have been made in mechanical details and principles that lessen the cost of protecting the crop and simplify the necessary machinery.

Recognizing the importance to our Western farmers of acquiring data upon which to predicate as to the probable action of the Rocky Mountain locust in 1882, I have had an agent specially engaged under the direction of the entomologist to gather such data in the permanent breeding grounds of this pest, lying for the most part in the thinly settled regions of the Northwest. Remembering the incalculable loss and suffering which this insect entailed between the years 1873 and 1877—losses which largely helped to prolong the commercial depression of that period—this information seems to me of sufficient moment to warrant annual observations of a more extended nature. There is an increasing interest manifested in the work of this division, quite out of proportion even to the rapid increase in agricultural production, and largely due to the greater attention now paid to applied science in our educational institutions and to increased facilities for intercommunication. The correspondence of the division is so large, and the requests for special information from all parts of the country so numerous, as to absorb too much of the time of the division; an increased clerical force and assistance are imperative. In order to relieve the division of much repetition in the replies, the entomologist will soon begin to prepare a series of well-illustrated bulletins, each treating of one of the more important of the insects injurious to our agriculture, and of such convenient form and size as to be cheaply and readily mailed. A bibliography of economic entomology, which has been commenced, will also facilitate this labor, as it will contain a digest of whatever has been published up to the present time, and a critical synopsis of remedies duly classified.

SEED DISTRIBUTION.

Tabular statement showing the quantity and kind of seeds issued from the seed division, Department of Agriculture, under the general and special appropriation act from July 1, 1880, to June 30, 1881, inclusive.

Description of seeds.	Varieties.	Senators and Members of Congress.	Agricultural societies.	Statistical correspondents.	Granges.	Special farmers.	Miscellaneous applicants.	Special distribution to sufferers by drought and grasshoppers.	Grand total.
		Papers.	*Papers.*	*Papers.*	*Papers.*	*Papers.*	*Papers.*	*Papers.*	
Vegetable	105	676,753	847	108,258	13,023	....	27,748	499,293	1,325,922
Flower	97	121,933	35	100	85	....	13,082	84	135,269
Sunflower	1	277	8	....	10	....	....	....	295
Tobacco	5	80,721	314	14,940	16,265	....	2,945	14	115,190
Herbs	10	10	....	....	....	....	128	....	138
Tree	4	266	14	2,088	....	....	1,194	22	3,588
Borage	1	....	....	....	....	....	....	12	12
FIELD SEEDS.									
		Quarts.	*Quarts.*	*Quarts.*	*Quarts.*	*Quarts.*	*Quarts.*	*Quarts.*	
Wheat	13	77,946	53	16,626	673	9,372	5,011	6,806	116,487
Oats	3	18,889	62	8,940	1,508	....	328	20,645	50,372
Field corn	8	11,209	68	3,906	3,278	....	779	13,282	32,522
Buckwheat	1	63	16	....	2,815	....	285	13,597	16,776
Potatoes	3	7,907	8	4,792	16	....	354	....	13,077
Grass	5	9,387	28	36	34	....	836	8	10,329
Clover	3	1,621	18	16	198	....	423	14	2,290
Sugar beet	2	75	154	6	20	....	485	....	740
Sorghum	12	7,967	230	16	4,294	....	2,060	64	14,651
Doura	1	....	....	....	8	....	87	7	102
Pea-nuts	1	229	20	....	6,796	....	13	....	7,058
Rice	1	90	4	10	1,781	....	258	....	2,143
Mangel-wurzel	1	....	16	4	84	....	49	6	159
Broom corn	1	21	....	....	....	....	32	....	53
Cotton	4	23,524	4	8	6,415	....	725	....	30,676
Jute .... papers	1	42	8	....	....	....	862	2	914
Total	283	1,038,950	1,907	159,746	57,303	9,372	57,634	553,860	1,878,772

Statement showing the quantity and kind of seeds issued by the Department of Agriculture to States and Territories ravaged by grasshoppers, under special appropriation by Congress of $20,000.

	Vegetable.	Flower.	Tobacco.	Tree.	Borage.	Grass.	Clover.	Jute.
	Papers.	*Papers.*	*Papers.*	*Papers.*	*Papers.*	*Quarts.*	*Quarts.*	*Quarts.*
Kansas	225,094	21	6	14	....	....	6	1
Colorado	36,752	7	....	2	....	4	....	....
Dakota	41,823	8	....	....	....	....	1	....
Nebraska[1]	196,124	48	8	10	12	4	7	1
Totals	499,293	84	14	26	12	8	14	2

	Doura.	Wheat.	Oats.	Buckwheat.	Sorghum.	Mangel-wurzel.	Field corn.	Grand total.
	Quarts.	*Quarts.*	*Quarts.*	*Quarts.*	*Quarts.*	*Quarts.*	*Quarts.*	
Kansas	4	2,587	6,921	4,428	21	....	3,894	242,997
Colorado	....	618	2,128	1,344	....	....	1,166	42,021
Dakota	....	292	302	1,396	2	....	1,996	45,320
Nebraska	3	3,309	11,294	6,429	41	6	6,226	228,522
Totals	7	6,806	20,645	13,597	64	6	13,282	553,860

STATISTICAL DIVISION.

The statistical division of the department, with a working force quite too small for the broad field which it is designed to occupy, has continued during the past year its plan of crop-reporting which was inaugurated early in the history of the department.

It has also collated current records of official boards, commercial organizations, and voluntary associations which hold relationship with agriculture, or with the distribution and sale of its products. As heretofore, it has attempted to supply the public demand for such information in systematic form, through published reports; the commercial and agricultural press; and in response to requests of departments, boards, societies, and individual publicists.

This is a work of constantly enlarging importance, in a field that is continental, with population rapidly increasing and production swelling in still higher ratio. It is a work demanded by the producer who would know where to find the best markets and highest prices; by the consumer who would seek abundance at a cost within his means, and without extortionate exactions of the carrier and the middlemen; and by the legitimate dealer who seeks protection, as does the farmer, against the piratical course of the reckless speculator. It becomes a necessity—an imperative duty, when opportune falsehood is able in a single day to wrench millions from the grasp of producers—that the government should forewarn and forearm the multitudes which represent its foundation industry.

This protection the statistical division of the department, if properly equipped and administered, can effectually accord.

To command public confidence and respect, to accomplish results commensurate in any good degree with the importance of the work to be done, enlarged means and facilities are an imperative necessity. The provision hitherto made for this branch of the department service has exceeded that accorded by a State legislature to its board of agriculture for a similar, though more limited purpose, yet the difference bears no proportion to the relative breadth of territory occupied. The record of current production and of the meteorological and economic fluctuations which constantly modify it throughout thirty-eight States and ten Territories, is of sufficient importance to call for ample means and unremitting endeavor.

The time has arrived when the crop-reporting system should be made more thorough and accurate and its results should be communicated to the public at the earliest possible moment. A synopsis of such results, furnished to the press by telegraph, should command general publication throughout the country in advance of the full printed report forwarded by mail. The co-operation of statistical authorities of States tending to uniformity, and inspiring increased public confidence, may be a possible consummation, as it is one greatly to be desired if practicable.

In several States this service, modeled upon the plan of the department, through manifest and profitable efficiency, has gained a strong local hold upon the confidence and regard of farmers and legislators.

While this system has thus been adopted in several States, and is already in operation in some European countries, its methods may possibly be improved, and its work may certainly be rendered more thorough by fuller information, and ampler elaboration and test of accuracy, thus leading to more uniformly reliable results. Its voluntary work, by thousands of public spirited farmers, should receive all practicable consideration and acknowledgment, and no reasonable expense should be spared to complete requisite data, and facilitate consolidation and embodiment in accurate results.

The marketing of surplus production in Europe, which is yearly assuming increased importance, makes it necessary to obtain prompt and trustworthy information of current crop reports of the world, and especially of European countries.

This department has already done something in this direction, yet more remains to be done in obtaining systematically and frequently the condition of foreign crops and results of foreign harvests.

While the changing area in special crops, their current condition in the growing season, and their harvest outcome hold prominent place, the whole field of statistical investigation in scientific and practical agriculture may be explored.

The relations of labor to proprietorship and production, the prices of lands and products, the peculiar adaptation of industries to localities, the rate of development of new and promising industries, and indeed the collection and co-ordination of all facts representing the status or the progress of agriculture come properly within the province of this branch of the department reserve.

FORESTRY.

The vast and increasing importance of the subject of forestry has led to the establishment of a distinct division in the department, to be exclusively devoted to such investigations of the subject as will tend to the fullest development of the resources of the country in that respect; the discovery of the best methods of management, and the preservation of our wasting forests, and the maintenance, in all its bearings, of the universal interest involved in that industry.

In furtherance of this design an agent of the department is now on a visit to different countries of Europe for the purpose of investigating the organization, working, and previous condition of experimental forest stations, schools of forestry, private tree-planting, and the aid afforded by governments to the business of forestry.

ARTESIAN WELLS.

By an act of Congress approved June 16, 1880, it was provided:

> That with a view to the reclamation of the arid and waste lands lying in certain Western States and Territories, the Commissioner of Agriculture is hereby authorized to contract for the sinking of two artesian wells on the plains east of the Rocky Mountains; said wells are to be sunk at such places as the Commissioner of Agriculture shall designate. * * * The sum of $20,000 is hereby appropriated to carry out the objects of this provision; the same to be disbursed under such rules and regulations as the Commissioner of Agriculture shall prescribe.

Acting under this provision my predecessor in office proceeded to make an examination of the arid country lying on the eastern slope of the Rocky Mountains in Colorado, and selected for the first trial well the arid plain a few miles from the Arkansas River, adjoining the military reservation of Fort Lyon.

On my accession to office an examination showed that on June 30 this well had been bored to the depth of 450 feet, at an expense of $18,353.55.

By an act of Congress approved March 3, 1881, an appropriation of $10,000 was made "For the reclamation of the arid and waste lands lying in certain Western States and Territories."

Realizing that the success of the well at Fort Lyon was not commensurate with its cost, and believing that the continuance of the work would absorb the additional appropriation, without practical result, I concluded to have an intelligent scientific survey made of the country to be benefited, and an examination made of the well at Fort Lyon. After conference with Prof. J. W. Powell, Director of the United States Geological Survey, I appointed Prof. C. A. White and Prof. Samuel

Aughey, both eminent geologists, with instructions to visit the well at Fort Lyon, and to explore the eastern slope of the Rocky Mountains with a view to determine proper sites for the location of wells in future, should such be the pleasure of Congress.

Hon. Horace Beach, of Wisconsin, a gentleman of large experience in sinking wells, was subsequently added to the commission. These gentlemen took the field in the latter part of August and prosecuted their labors as long as the season would allow. A preliminary report of this commission accompanies this (Appendix A).

Acting upon the information contained in the report of these gentlemen, that the well was not located in a section of country geologically promising success, I have suspended work upon it for the present.

AGRICULTURE OF THE PACIFIC SLOPE.

By act of Congress approved March 3, 1881, an appropriation was made of $5,000, "to enable the Commissioner of Agriculture to procure and publish data touching the agricultural needs of that portion of the United States lying west of the Rocky Mountains."

To carry out this provision, I appointed Prof. E. W. Hilgard, of the State Agricultural College of California, Hon. Robert W. Furnas, of Nebraska, and Hon. T. C. Jones, of Ohio, commissioners, with instructions to investigate and report upon the cultivation of the grape on the Pacific coast, and especially the inducements offered by the soil and climate of New Mexico for vine culture in reference to supplying the market with valuable grapes, wines, and raisins; to report upon the animal industries of that section, and to examine and report upon the agricultural methods prevailing, and the general management of land for horticultural as well as agricultural purposes.

This commission took the field in the latter part of August, and I shall have the pleasure of laying their report before Congress early in January.

EXAMINATION OF WOOLS AND ANIMAL FIBERS.

The work of examination of wools during the past year has been almost exclusively devoted to the continuation of the measurement of the fineness of the fibers, and the mathematical calculations necessary to the presentation of the results in such form that they may be readily understood by all interested in the woolen industries, in every part of the world, whether they be producers, dealers, or manufacturers.

It is difficult, by a written description, to make one, unacquainted with the methods necessarily involved in the accurate execution of this work, comprehend the amount of tedious and patient labor required, but an approximate idea of it may be obtained from the fact that it has been necessary to make with the microscope at least 75,000 individual measurements of fibers, the immediate results of which, to secure the accuracy desired, were of necessity relative, so that each one had to be reduced by calculation to the absolute standard. We have thus measured in all about 600 samples of wool of different qualities, making altogether about 2,100.

An interesting feature of our work is found in the fact that through the courtesy of Mr. William G. Markham, secretary of the National Association of Wool Growers, we have been able to make measurements of wools from Germany, graded by one of high authority on the subject of the German system of classification, so that we are able to present authoritative figures for the comparison of the fineness of our own wools with the celebrated products of the old world.

In this comparison we find that many of our manufacturers are at fault, when they complain that it is impossible to obtain in this country wools of the fineness required in the best work. It enables us to confidently affirm that it is possible to produce in the United States as fine wools as can be produced in any other part of the world; and further, that the fineness of the products of the Saxony and Spanish merinos have not deteriorated since their introduction to this country, wherever the maintenance of this quality has been kept in view by the breeders.

Examination of the felting properties of the wools has not yet been begun, because our time has thus far been fully occupied with the work connected with the measurements of fineness, and of the tensile strength and of some of the mechanical difficulties involved, requiring the construction of special apparatus, both to facilitate and hasten the operations, as well as to insure perfect accuracy in the results.

This apparatus is now in course of construction, and will in a very short time be put into actual operation. It is expected that this branch of our investigation will give exceptionally interesting data, upon which to base estimates of the commercial and manufacturing value of the wools brought to our markets. In the measurements of the tensile strength, ductility, and elasticity more progress has been made.

A large number of samples have been prepared for examination of the minute structure of the fiber, as modified by the breed and the conditions to which the animals producing the fiber may have been subject. The limited observations that we have made in this direction indicate that it will prove an important field of inquiry, and that the results that are possible may have a bearing upon the determinations of the purity of any given breed under consideration.

Our report upon this inquiry will be accompanied by drawings, illustrating the peculiarities to which we refer. A large amount of labor is still necessary for the completion of the investigation as contemplated by the act of Congress ordering it. The work is being pushed forward with all due diligence and rapidity, and it is hoped that provision will not only be made for its entire completion, but that we may be enabled to extend our researches to wools of other sections of the country, and produced under different conditions of breeding, feeding, management, and climate.

I would suggest that an examination of cotton fibers, produced under different conditions of variety, culture, soil, and climate, should be undertaken and prosecuted in a similar manner, and there can be no doubt that, if the suggestion be adopted, the results obtained will be of quite as great value to the cotton industry as those we have already obtained are to the woolen industry.

The results of the proposed examination of cottons would make additions of an entirely new character to the literature of the fiber, for we know of no investigations looking to the determination of the tensile strength, at least. And there is just now a very favorable opportunity for securing the material for examination in the International Cotton Exposition being held in Atlanta, Ga., where samples from all parts of the world will be obtainable.

GRAPE CULTURE AND WINE-MAKING.

During the past year there has been in course of preparation a report upon the culture of the vine, and the manufacture of wine in Europe, having for its object an exposition of the more important principles upon which this great industry is based, and upon which success in its prosecution depends.

The work is governed by the idea, that for wine-making in this country it is better for those desiring to enter upon this branch of agricultural industry to begin with inexpensive methods and arrangements, to produce large crops of wines of medium quality, which may be early sent to market and sold at low prices, and thus made to yield quick and profitable returns, rather than from the first to attempt to produce wines of high grade to rival those of the more celebrated qualities of the old world. The latter is believed, with our new vineyards, comparatively new varieties, and general want of knowledge and experience on the subject, to be practically impossible, and that it may therefore be accepted as a general rule that it is better to devote all possible energy to the production of good, healthy table wines for the present, and wait for the larger experience this will afford and the accession of new varieties to lead to the production of wines of higher grades.

With this end in view it has been the endeavor in the preparation of this report to present those principles of vineyard and cellar management, as may be applied, with the greatest measure of economy and the greatest probability of yielding profitable results. It is hoped that this report will be completed and ready for publication early in February next.

MANUFACTURE OF SUGAR FROM SORGHUM.

Congress at its last session appropriated the sum of $25,000 for expenses of machinery and apparatus, labor, &c., to continue experiments in the manufacture of sugar from sorghum and other sugar-producing plants, the appropriation to be made immediately available. My predecessor had purchased the machinery and other apparatus, appointed several additional chemists, and made contracts with parties residing near the city to raise the sorghum cane for experiment. Upon assuming the duties of the office I found growing 135 acres of sorghum cane, consisting of 52 varieties. One of the farms on which this cane had been planted was within the city limits, the other two were located some distance beyond the boundary. Having engaged the services of an expert in sugar-making, who had been highly recommended for the position, operations were commenced at the mill on September 26, and continued with slight interruptions until the latter part of October, at which time the supply of cane became exhausted. Forty-two acres of the 135 planted in sorghum were overtaken by the frost before sufficiently ripe for use, and the crop was so badly damaged as to be regarded as unfit for experiment.

The following condensed statement gives the results of the operations for the season:

Statement showing amount of sorghum cane raised, amount manufactured into sugar and sirup, and to cost of raising and manufacturing.

Acres of cane passed through crushing-mill	93.5
Yield of cane per acre in pounds	4,903
Pounds of cane crushed	458,444
Gallons of juice obtained after defecation	26,794
Pounds of sirup obtained	34,985
Gallons of sirup obtained	2,977
Pounds of sugar obtained	165

The expenses of raising the cane were as follows:

Rent of land	$1,854 00
Labor and superintendence	3,474 22
Tools and implements	347 13
Hire of teams and hauling cane to mill	914 10
Total	6,589 45

Expense of converting the cane raised into sirup and sugar:

Paid for labor and running mill	$1,342 11
Coal and wood	325 48
Total	1,667 59

Of the sirup made there has been sold 2,328 gallons, at 33 cents per gallon, and the money covered into the Treasury.

TEA CULTURE.

At the last session of Congress an item was included in the agricultural appropriation bill providing $10,000 for experiments in connection with the culture and manufacture of tea.

On entering upon the duties of my office as Commissioner, I instituted a careful examination of the condition of this enterprise both financially and economically. The disposition of the appropriation I found to be as follows:

Surveying	$225 00
Furniture	116 00
Iron safe	365 00
Wagon and harness	252 00
Salaries, labor, and expense account	3,377 11
Total	4,335 11

In order to ascertain the precise condition and value of the experiment being carried on in South Carolina, I directed, on July 9, Mr. William Saunders, the horticulturist of the department, to proceed to Summerville and to examine the premises and report upon the work. His statement, which will be found in full in Appendix B, sets forth that the 200 acres of land selected for the experiment are most of them covered with a heavy forest growth, the soil being "poor, hungry sand," of a character "to support only the scantiest kind of vegetation." Of this, about 15 acres had been cleared and was under a primitive cultivation. On these acres operations were commenced in January last; a space was prepared for sowing the tea seed, and preparation was made for covering the plants, which when young suffer severely on being exposed to the sun. The plants were growing well and constituted the entire tea crop of the farm. Mr. Saunders reported that "with regard to the future prospects of the enterprise, if continued in the line of the present scheme and under the present system, it may be said that there is not much room for encouragement." The poverty of the soil and the character of the climate, in which frosts sometimes occur, seem to be unfavorable to the production of strong, highly-flavored teas, as had already been proved by an experiment in McIntosh, Ga.

As to the future management of the tea farm [says Mr. Saunders], following the conviction that no experiment which can be made in the culture of tea at this place will warrant a continuation of the undertaking, it may be suggested that expenses be cut down to the lowest figures admissible; that all operations of clearing the ground of stumps and trees be stopped at once; that until further notice the mule team be employed in deep plowing, harrowing, and putting in thorough condition for planting about 6 acres of the best portion of the cleared land, which can be used for the formation of a nursery of tea plants if desired; that the expensive superintendence be modified, so that $300 per month will not be paid for the management of $60 worth of labor during the same period of time, as at present, and that all labor cease, except so much as may be found necessary to look after the young plants.

Acting on this advice, I have disposed of all the animals except one horse; have removed a large portion of the outfit to Washington, and have employed one person, whose duty it is to look after the growing plants, of which a few thousand have been distributed by the department. In concluding his report, Mr. Saunders says:

In a general way it may be stated that since July 1, 1880, $15,000 have been appropriated by Congress for the encouragement of tea culture. So far as is visible to the ordinary observer, the only practical, palpable result of expenditures from this fund is what is to be found and what has been done on this farm.

CONTAGIOUS DISEASES OF DOMESTICATED ANIMALS.

On assuming control of the Department of Agriculture I found that my predecessor had provided for a continuation of the investigation of contagious diseases of domesticated animals by assigning to duty those previously employed and the appointment of an additional number of veterinary surgeons. This additional force seems to have been made necessary by the increased duties imposed by Congress in making an appropriation for the purpose of determining the extent to which the disease known as contagious pleuro-pneumonia exists in the States heretofore reported as infected with the malady. Agents for this purpose had been appointed in the following-named States: New York, New Jersey, Pennsylvania, and Maryland. Two surgeons had been appointed in New Jersey, one of whom had been directed to make examinations also in Delaware.

The agent in Maryland had been directed to extend his investigations into the District of Columbia, and such counties on the eastern border of Virginia as he might be able to visit. As these agents were engaged in an active prosecution of the investigation, it was thought best to continue them until the work was completed, or at least until satisfactory evidence was obtained as to the prevalence or non-existence of this destructive disease in the territory above named.

Notwithstanding the many disadvantages under which these agents have labored, being without either State or governmental authority for making inspections, their reports indicate the existence of contagious pleuro-pneumonia among cattle in the above-named States and in the District of Columbia. While but comparatively few acute cases of the disease were discovered, many chronic cases and numbers of infected stables, premises, &c., were found in a majority of the localities visited.

The reports of these veterinary surgeons will be submitted in detail hereafter.

In addition to further experiments for the purpose of more accurately determining the nature of the diseases known as swine plague and fowl cholera, Dr. D. E. Salmon had been instructed to institute and carry out as thorough an inquiry as possible into the nature and peculiar characteristics of the fatal disease among cattle known as Spanish fever. This inquiry was regarded as necessary for the purpose of more definitely determining the nature of the virus or infecting principle of the disease —the part of the body in which this virus multiplies, and the manner in which it is excreted and conveyed to healthy animals.

To properly understand this disease it would seem necessary to know how an animal, apparently healthy, can be the means of so widely disseminating so fatal a malady, and why those actually affected with it in its most destructive type are unable to transmit it to other animals.

Another equally important point to be determined is, as to how the virus of this disease can become acclimated and resist a temperature much lower than was formerly possible, and to what extent this acclimation may continue, and consequently what danger there may be of the Northern States becoming permanently infected in the future. These points once clearly and definitely established, much more effective measures for the prevention of the disease may be devised than are now possible.

The past season has been rather an unfavorable one for the successful prosecution of this investigation, owing to the fact that the disease has prevailed to a much less extent than in former years. Dr. Salmon has, however, made some important discoveries in regard to the transmission of the malady, having already successfully inoculated several He is still engaged on this branch of his work, and as soon as the results of his experiments are more definitely determined, a detailed report of his investigation will be transmitted for the consideration of Congress.

Dr. H. J. Detmers was instructed to continue his experiments with the disease known as swine plague, with special reference to ascertaining what agents seem to offer the best results when used as prophylactics. He was advised to put to a practical test, on a large scale, the subjects selected for experiment. By studying the disease in large herds, and watching closely the effects of the agents used, it was thought that a cheap, simple, and efficient preventive of this destructive disease might be discovered and a lasting benefit thus conferred on the farming community and the nation generally. A full report of the results of his experiments will be submitted hereafter.

In addition to the above-named diseases, which require still further experiments to definitely determine all their peculiar characteristics, there are many other destructive contagious maladies which, as yet, have received no consideration at the hands of this department.

The most important, because the most fatal and destructive, of these diseases is that of anthrax or charbon. Many classes of our domesticated animals are subject to this disease, and perhaps the annual losses from this malady are heavier than from any other single disease now prevalent among our farm animals. While the investigations referred to were going on in this country, Dr. Lyman, a veterinary surgeon who had been employed for that purpose, was pursuing his investigations in England with regard to the alleged existence of pleuro-pneumonia and foot and mouth disease among cattle landed in that country from the United States. He was accompanied by Professor Whitney, the accomplished microscopist, and the results of his scientific inquiry and of his conferences with the privy council are interesting and valuable. He was instructed by my predecessor to continue the investigations undertaken by the department in England the previous year. In an interview with the privy council Dr. Lyman requested that an examination of portions of diseased lungs taken from the cattle condemned last year might be made by the veterinary surgeon of the council and himself unitedly, at the same time assuring them that no pleuro-pneumonia had been found West, and that this department had employed competent officers to inspect all suspected districts along the Atlantic coast. As the result of the examination, the British veterinary surgeon, Dr. Brown, expressed the opinion that there need be no occasion for alarm in the future with regard to condemning cattle, and that "if the United States was entirely free from pleuro-pneumonia no condemnations would be made upon lungs presenting the appearances only of those that were condemned last year." It appears that out of 32,000 animals imported into English ports, outside of Liverpool, in six months ending June 25, 1881, only 35 had been condemned even under the suspicion of having contagious pleuro-pneumonia. And Dr. Lyman remarks that—

> As a result of my conference with the authorities of Great Britain upon this subject, I think it may safely be stated that the impressions which they held regarding the health, in this respect, of our western herds, have been materially changed, and that lungs, having a certain appearance, heretofore condemned as being of contagious pleuro-pneumonia, will not be so considered in the future.

Between January 1 and May 31, 1881, large numbers of American cattle landing at London, Liverpool, and Glasgow were considered as having foot-and-mouth disease. Careful investigation shows that the disease, if it existed, was caused by infection communicated to the cattle after they were shipped from American ports, and is to be attributed to exposure to the virus imported into England from France, and spread abroad from Deptford market, where it was first discovered. It is considered possible that the disease may be imparted to American cattle by the use of the head-ropes, which are often taken from diseased European animals and used on board American vessels employed in the cattle trade, and also by taking on board these vessels articles for shipment from wharves where diseased cattle have been landed. If this theory is true, legislation will be required to remedy the evil. Dr. Lyman reports that during his stay in Great Britain no diseased hogs were landed from the United States. He quotes from the report of the veterinary department of the privy council for the year 1879 a statement showing that out of 279 portions of swine flesh taken from American hogs that had been condemned and slaughtered on account of swine fever, only three were found to contain living trichinæ. The British report, after giving as a reason why the direct importation of American pork was not prohibited, that "such a measure would have damaged the trade without producing any satisfactory results," continues: "Besides, trichinosis among swine is known to exist in Germany, and it probably exists in other exporting countries, so that nothing short of prohibition of swine flesh in all forms from all foreign sources would have been effectual." "In view of the recent total embargo placed by some of the foreign governments upon the imports of our hog products on account of the alleged existence in them of trichinæ," it is recommended that measures be taken to ascertain more definitely what percentage of American hogs are thus diseased, the geographical distribution of the disease in this country, and all other information which may aid in devising such means as shall decrease to a minimum their existence in American pork products.

With regard to the transportation of cattle to the European markets, I am happy to say that American cattle, shipped from American ports, "arrive at their destination with fewer bruises and in better condition generally than do those from some of the neighboring European ports."

The losses of cattle on ship-board from January 1 to September 30, 1880, exceeded 5 per cent. In the corresponding months of 1881 the losses were about 2½ per cent.

SUGAR FROM BEETS.

Under the act of Congress appropriating $10,000 "for the continuation of experiments in connection with the manufacture of sugar from beets, and for the cultivation of beets for that purpose," my predecessor contracted for improved English and French implements for cultivating the beet, which were to be loaned to the Delaware Beet Sugar Company, at Wilmington, Del. I have carried out the agreement made by him, and in addition thereto have contracted for a large quantity of selected seed of the sugar beet for distribution to those persons who shall agree to grow the beet for sugar-making purposes.

DISBURSING OFFICE.

The following table exhibits in a condensed form the appropriations made by Congress for this department, the disbursements and unexpended balance for the fiscal year ending June 30, 1881:

Object of appropriation.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$69,200	$69,185 22	$14 78
Collecting statistics	10,000	9,985 60	14 40
Purchase of seeds	80,000	80,000 00	....
Experimental garden	7,600	7,600 00	....
Museum and herbarium	1,000	1,000 00	....
Furniture, cases, and repairs	5,000	5,000 00	....
Library	1,000	1,000 00	....
Laboratory	4,000	4,000 00	....
Contingent expenses	10,000	9,745 49	254 51
Postage	4,000	4,000 00	....
Improvement of grounds	5,000	5,000 00	....
Printing and binding	11,000	11,000 00	....
Report on forestry	5,000	3,762 51	1,237 49
Investigating the history and habits of insects	5,000	4,997 31	2 69
Investigating the diseases of swine, &c	10,000	10,000 00	....
Examinations of wools and animal fibers	4,000	4,000 00	....
Machinery, &c., for experiments in the manufacture of sugar	7,500	7,500 00	....
Data respecting the needs of arid regions	5,000		....
Reclamation of arid and waste lands	20,000	18,353 55	1,646 45

Very respectfully,

GEO. B. LORING,
Commissioner of Agriculture.

APPENDIX.

A.

Hon. Geo. B. Loring,
Commissioner of Agriculture:

Sir: In accordance with your verbal request, we herewith submit to you, in advance of our final report upon the general subject of locating artesian wells upon the arid plains of the West, a brief report upon the experimental well which is now being bored near Fort Lyon, Colo., under the auspices of the Agricultural Department.

At the time of our visit there, September 1, of the present year, the boring had reached a depth of 658 feet, and the work was still in progress. No water was flowing from the bottom of the boring then, but the superintendent in charge of the work reported to us a constant flow of water at the surface, and as coming from a point in the boring 430 feet beneath, at the rate of 3 gallons per hour. This amount is too small to be regarded as of any practical importance, and the boring may, therefore, be regarded as thus far an unsuccessful one.

After a somewhat careful investigation of the geology of that vicinity, we reached the conclusion that even if the boring were to be continued until the granitic or unstratified rocks are reached (which would probably be within less than 1,000 feet beneath the lowest point which the drill had reached at the time of our visit), it is very probable that a plentiful supply of water will not be obtained then. Our reasons for this opinion are explained in the following remarks.

In our final report we shall discuss the dips of the strata within the region which we examined during the past summer, together with their lithological characteristics, as those questions are found to bear upon the probabilities or otherwise of obtaining water by means of artesian borings. Anticipating briefly a portion of this discussion, we may remark, that while pursuing our investigations in the valley of Arkansas River, in which valley the boring in question has been located, we ascertained to our satisfaction that from a short distance east of the town of Pueblo to the eastern boundary of Colarado that river runs upon a gentle anticlinal axis; that is, while the surface of the region adjacent to the river valley slopes towards the river upon both sides, the strata which underlie the surface dip away from the river both northward and southward. There is also a general eastwardly dip of the same strata, which we ascertained to coincide almost exactly with the slope of the stream, which slope is estimated at some six or eight feet to the mile, but the dip of the strata is not quite so uniform as the slope of the stream; that is, there are very gentle and broad undulations of the strata, which bring, for example, certain readily recognizable layers a little above the level of the stream at some places, and at others passing them a little beneath it.

Now, we find that the boring near Fort Lyon has been located upon one of those gentle rises of the strata, which has brought to view in the banks of the river there the certain layers referred to, which, in their extension, are beneath the level of the river above that locality, and which also pass beneath the level of the river a few miles below it. According to these determinations, there is a slight dip of the strata in all directions away from the neighborhood in which the boring is located, of which dips the whole series of stratified rocks, the deeper as well as those which are visible, which underlie that locality, doubtless partake.

Applying the well-known theory of artesian wells to the condition of the strata in the neighborhood of Fort Lyon, as we have explained it, an unfavorable result may be reasonably expected from the boring now being prosecuted there.

If that region were a humid instead of an arid one, and the earth there was saturated with water, as it is in humid regions, it is believed that the unfavorable dips of the strata which have been referred to are so slight that a fair supply of water might possibly rise to the surface in the boring near Fort Lyons by means of the general favorable dip to the eastward, which all the strata have been shown to have in the region of the Arkansas Valley. But it is believed that in so dry a region borings are likely to prove really successful only in the most favorable localities as to dip and character of strata.

We ascertained that the boring near Fort Lyon had been begun upon the Colorado or middle group of Cretaceous strata near its base, the valley there being excavated out of the upper portion. The drill had passed through the remainder of this group; then through the Dakota or lower group of the Cretaceous series; then through the Jurassic series, and into the Triassic.

In consequence of the destruction or disarrangement of a large portion of the core which had been brought out of the boring by means of the diamond drill before our arrival, we were not able to study fully the fine section of the strata which had been pierced by the drill which that core would have presented if it had been carefully preserved.

By examination of the portions of the core that were preserved in connection with the statements furnished us by the superintendent in charge of the work, we assigned to each group of strata that had been pierced by the drill the thickness expressed by the following figures:

	Feet.
1. Colorado group, Cretaceous	100
2. Dakota group, Cretaceous	300
3. Jurassic	250
4. Triassic	28

The drill had passed into the Triassic group of strata only about 28 feet, and it is known that much more of that group yet remains to be pierced. The foregoing measurements indicate that the several groups of strata, which have been passed through by the drill, are considerably thinner than they are where they are upturned against the base of the Rocky Mountains, about 100 miles to the westward. This fact indicates that all the groups of strata beneath that portion of the great plains will be found to grow thinner to the eastward from the mountains; and that therefore the whole series of stratified rocks which exist there may be pierced by boring a considerable distance out upon the plains at a much less depth than they would be nearer the mountains where the aggregate thickness of those strata, as seen, where they are upturned against the mountains, is very great.

We infer from this also that the Triassic group in which the drill is now working in the boring, near Fort Lyon, is there probably not more than 1,000 feet thick, and that it may be considerably less.

At the base of the mountains the Triassic strata rest directly upon the granitic or non-stratified rocks, and they probably do the same beneath Fort Lyon. If so, the base of the Triassic and of the whole series of stratified rocks which exist there will be reached by not exceeding 1,000 feet more of boring. We also think it is barely possible that water may rise to the surface in that boring, when the base of all the stratified rocks there is reached by the drill, but, as before explained, we believe such a result to be very doubtful.

We are clearly of the opinion that in any case it will be useless to continue the boring into the non-stratified rocks.

Since you have expressed a wish that we should be explicit in the expression of our views upon this subject, we may add that believing the conditions of the strata which underlie the surface in the vicinity of Fort Lyon to be unfavorable to success in obtaining a satisfactory flow of water from the boring now in progress there, a permanent discontinuance of the work at any time would be justifiable.

As geologists, however, we would much prefer to have the work continued and the core of the drill carefully preserved until the non-stratified rocks are reached. We also beg to improve this and every opportunity to recommend the use of the core-drill in all future borings that may be made under your direction, because the preserved core of such borings will give us a knowledge of the geological structure beneath the surface of the great plains that can be obtained in no other way.

We have constantly declined any communication or correspondence with any and all persons interested in well-boring machinery of any kind, and we make the above recommendation wholly in the interests of geological science.

Very respectfully submitted.

C. A. WHITE,
SAMUEL AUGHEY,
Commissioners for locating Artesian Wells upon Arid and Waste Lands.

WASHINGTON, D. C., *November* 9, 1881.

B.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: In accordance with your letter of July 9, instructing me to proceed to Summerville, S. C., for the purpose of examining and reporting upon the condition and prospects of the government tea garden, investigate as to its agricultural, financial, and general condition, the property of the government connected with it, the expense of continuing it upon the present basis, the progress of the culture hitherto made, the future prospects of the enterprise, and make a thorough examination of the whole matter, I have the honor to submit the following report:

Leaving Washington on the morning of July 12, I reached Charleston on the forenoon of the 13th, too late for the morning trains to Summerville; that station was not reached until evening.

Early on the moning of the 14th I proceeded to the farm and spent the day, as also the following day, inspecting the property.

The land leased by the department consists of 200 acres, most of which is covered with a heavy forest growth which may be cleared and fitted for plowing at an expense of from $50 to $100 per acre. I understood Mr. Jackson (the superintendent) to say that the lowest bid he had received for clearing the forest growth was $80 per acre.

A portion of the estate, immediately surrounding the ruins of the old mansion, was comparatively cleared, scattering stumps and trees only being left. The removal of these and other *débris* has been nearly completed over something like 15 acres, all of which is nearly ready for the plow; and, indeed, with the exception of 4 or 5 acres, has been plowed this spring, and most of it sown with cow-pea, to be turned under as a fertilizer.

The soil is a poor, hungry sand. Some portions of the tract might be classed as a poor, sandy loam (as some appearance of loam may be detected in it), but it is of a character to support only the scantiest kind of vegetation.

A course of ameliorative culture, including manuring, would be required before attempting to procure reasonably satisfactory crops of even such annual maturing plants as are usually grown in that climate; but for permanent ligneous plants, such as the tea plant, a much more thorough preparation than that conveyed above would be essentially necessary, including deep plowing and cross-plowing, followed in each furrow by a deep subsoiling, to prepare a proper physical or mechanical condition of soil for the free ramification of roots.

With regard to the progress of the work, operations were commenced during January of this year. The first object was to prepare a space to sow the tea seeds as soon as they arrived, and prepare shading material to cover them, as the young plants suffer severely when exposed to the sun.

The shading here is accomplished by using clapboards laid closely together upon a frame-work elevated about 18 inches above the surface of the ground.

The seeds were sown as soon as they arrived, and they have germinated very satisfactorily, and will furnish plants for many acres. These are the only tea plants on the farm.

Acting under instructions received from the department, the superintendent has marked out a straight road 60 feet in width, which courses through the center of the cleared ground, crossing an old artificial lake, which is bordered by trees and low vegetation, and which possesses a considerable degree of rural beauty. The crossing over the lake is proposed to be effected by an iron bridge. This is to be substituted for the present road, which gracefully follows the curving outline of the lake at about 30 feet from the straight road now in course of formation.

The ruins of the old mansion comprise a large quantity of broken bricks and old mortar. This is now being removed and used for making the above-mentioned road. The instructions to the superintendent called for the complete clearing out of this old material, so that a ground plan of the old house could be secured with a view to restoring the building.

This brief description shows the condition of the farm, the general character of the soil, and the progress made in the culture of the tea *plant*.

With regard to the future prospects of the enterprise, if continued in the line of the present scheme and under the present system, it may be said that there is not much room for encouragement.

A few remarks relative to the position of tea culture in America, as at present understood, may assist us in arriving at an intelligent view of the matter. For the past twenty years the department has annually distributed a number of tea plants, in varying quantities of from 10,000 to 50,000 plants yearly, the object in view being to introduce the plant to the notice of farmers and planters, so that they could familiarize themselves with its characteristics and its adaptability to climates and localities; also, that experiments might be made with the leaves in the preparation of an article for domestic use.

In many instances this was so satisfactory as to encourage further plantings, so that small plantations of one-fourth of an acre and upwards in extent were here and there to be found. Many of the samples of tea prepared in a domestic way were pronounced to be very good, and the department for the past twelve years or more has frequently been the recipient of teas which were creditably manufactured, and otherwise considered commendable. In the latter part of the year 1879, Mr. J. Jackson, the present superintendent of the tea farm at Summerville, who had been for many years engaged in the manufacture of tea in British India, being in the United States on a pleasure tour, had his attention called to the efforts of the department in the introduction of this industry; and looking over the matter he concluded to purchase one of the largest of these incipient tea plantations, situated in Georgia, for the purpose of making experiments in the manufacture of tea. His first effort at the manufacture was made in the spring of last year (1880), and the result was deemed encouraging; samples of his teas were received by the department where they were exhibited and tested; but while the manufacture and appearance of the teas were commended they were pronounced to be deficient in strength.

During last fall and winter Mr. Jackson gave special attention to the plants in the way of pruning, manuring, &c. In consequence, the plants made a most satisfactory growth, giving five crops of leaves, which allowed Mr. Jackson a fair opportunity to test the cost of manufacture, which has convinced him that teas may be placed on the market at a cost not exceeding twenty-five cents per pound. This crop has also been tested by experts, and their opinion again shows that the teas are deficient in strength.

About 20 pounds of this crop was sent to the department, from whence it was distributed for testing as samples of American tea. It is therefore evident that the great defect of these teas is lack of strength.

It is an established fact that the strength of teas depends upon the climate where the plant is grown. The warmest tea climates produce the strongest teas.

Teas produced in localities where frosts occur are always pronounced to be weaker than teas which are produced in localities where the thermometer never reaches to the freezing point. This is well understood in all tea-growing countries, and it certainly would not be wise to ignore the fact in making experiments in this country.

The position may be considered as fairly represented as follows: Having every reason to conclude that the locality near McIntosh, Ga., is too far north for the production of teas which possess sufficient of strength and pungency to command the best prices, or even profitable prices, it is therefore considered proper to try the experiment at Summerville, S. C., which is one and a half degrees further north!

However unfortunate it may be, it is clearly evident that the tea experiments must be made in a more southern latitude. The State of Florida may be looked upon as presenting the most favorable conditions, and if the experiments are to be proceeded with, operations should be transferred to that State without delay.

I found the property of the department, as per abstract furnished me, all well cared for. In addition, I found a saddle-horse for the superintendent, and several other items of recent purchase.

As to the future management of the tea farm, following the conviction that no experiment which can be made in the culture of tea at this place will warrant a continuation of the undertaking, it may be suggested that expenses be cut down to the lowest figure admissible; that all operations of clearing ground of stumps and trees be stopped at once; that, until further notice, a mule team be employed in deep plowing, harrowing, and putting in thorough condition for planting about 6 acres of the best portion of the cleared land, which can be used for the formation of a nursery of tea plants, if desired; that the expensive superintendence be modified so that $300 per month will not be paid for the management of $60 worth of labor during the same period of time, as at present, and that all labor cease, except so much as may be found necessary to look after the young plants.

In the matter of finance, the accounts in the office of the disbursing clerk of the department can be referred to at any time for details.

In a general way, it may be stated that since July 1, 1880, $15,000 have been appropriated by Congress for encouragement of tea culture. So far as is visible to the ordinary observer, the only practical, palpable result of expenditures from this fund is what is to be found and what has been done on this farm. The only building on the property is a small shed-looking house, which is used as an office. There is no stable conveniences; the mules and the horse are kept in a rented stable at Summerville, about 3 miles from the farm.

Very respectfully, your obedient servant,

WILLIAM SAUNDERS,
Superintendent of Gardens, &c.

WASHINGTON, D. C., *July* 19, 1881.

CONTAGIOUS PLEURO-PNEUMONIA AND FOOT-AND-MOUTH DISEASE.

FOURTH REPORT OF CHAS. P. LYMAN, F. R. C. V. S.

Hon. GEO. B. LORING,
Commissioner of Agriculture:

SIR: Congress, at its last session, appropriated the sum of $15,000 for the purpose of enabling the Department of Agriculture to ascertain, as accurately as possible, all facts in relation to the existence of contagious pleuro-pneumonia among cattle in the United States. For this purpose there were appointed, in March last, several veterinarians of experience with this disease, who were located at various points throughout the entire infected region and directed to collect all information which should enable them to point out the exact location of all herds of cattle within a certain prescribed district, for each one, that might be affected with the disease. They were also ordered to report the general drift of the movement of cattle within such district, so that, in case evidence might be found that such animals were being collected for shipment, or were being shipped out from the district, early knowledge of the fact, together with information relating to their probable destination, might at once be communicated to this department. Much of this work has been accomplished, and the result of their investigations will be found detailed in the accompanying reports which I have the honor of presenting to you herewith.

While in this way it was thought that statistics of value as to the number of diseased animals and the distribution of the malady over the infected area might be gained, it was well understood that the reports would not, in the nature of the circumstances under which the data must necessarily be collected, be anything more than approximations of the truth, and as such, simply, they are offered, with the hope and in the conviction that they will prove to be of service to any who may desire to make computations which shall show the probable number of cattle that would have to be paid for in case "stamping out" with remuneration was decided upon as a means of ridding our country of this foreign disease. And, further, it was thought that it would show what became of dangerous cattle, more especially of the calves from such districts, for, within the past year, much has been very properly said and written as to the danger of transplanting this disease into the great herds of the West by means of a trade to them of Eastern-bred calves, a danger which it seemed to be of great importance to have accurate knowledge concerning, that restrictive measures, were they found to be necessary, might at once be undertaken. While the examinations by these inspectors are more thorough than any heretofore made by the government, still I must confess to a disappointment; for when it is borne in mind that whatever inspections are made, whatever advice concerning the disposition of diseased and infected animals is followed, that, in fact, whatever knowledge of any kind regarding the absolute condition of these herds was to be had only by and through the courtesy of the cattle owners themselves, many of whom, I am sorry to say, have thrown unexpected obstacles in the way, it will be seen that the reports cannot be as full and complete as the necessity demands. These remarks do not apply, however, to the States of Pennsylvania and New Jersey, where the secretary of the State board of agriculture, Hon. Thos. J. Edge, in the former, and the secretary of the State board of health, E. M. Hunt, M. D., in the latter, have rendered such cheerful and powerful assistance that the reports from these two States should be looked upon as being more than approximately correct.

From the honorable the Commissioner of Agriculture I received in May last the following instructions:

"You will, on or about the 10th day of June, proximo, take passage for Great Britain, and having arrived there you will continue your investigations undertaken for the Department of Agriculture, in England, last season. These examinations may be pursued by you during the summer months or such a part thereof as may be found necessary, at such port or ports of Great Britain as the circumstances exising from time to time may seem to demand.

"It will be well if you can persuade the veterinarians employed by the Government of Great Britain to join you in making a thorough examination of any animals, or lungs thereof, arriving from the United States that may appear to them to show symptoms or lesions of contagious pleuro-pneumonia, with a view to the settlement, if possible, of the present contested question as to whether the animals now so freely condemned by them as showing the presence of this disease really do have it, or if the lesions of some other disease have been mistaken for it, as is shown by the result of your own examination of the lungs of animals that were pronounced by the British authorities to be unmistakably affected by pleuro-pneumonia *contagiosa.*

"As a part also of your duties you will, so far as possible, examine in a proper manner the hogs arriving in Great Britain from the United States during your stay there, with a view of ascertaining to how great an extent they are diseased or are infected with trichinæ.

"You will also investigate, so far as possible and as circumstances may seem to demand, the question of the existence of any other contagious diseases that may be present or alleged to be present among any animals arriving in Great Britain from this country."

In accordance with these instructions, I have the honor to report that upon June 24 I arrived in London, and the next day called upon the Right Hon. Mr. Mundella, Vice-President of the Privy Council, to whom I presented my credentials and stated the objects of my mission. He said that the matter seemed to him to be of great importance, and that it had best be laid at once before the Lord President of the Council, and for this purpose he appointed so early a time as one o'clock the following Monday, June 27.

At the hour designated, in company with his excellency Minister Lowell and Dr. Whitney, pathologist, I proceeded to the Privy Council Office, where we were received by the Lord President, Earl Spencer, the Vice-President, the Right Hon. Mr. Mundella, the secretary, Mr. Peel, and the Veterinarian-in-Chief, Professor Brown. Mr. Lowell introduced us and briefly stated the object of our visit, saying that, as the particular request we had to make to the Council had been reduced to writing, with his lordship's permission he would proceed to read it. Dr. Whitney then read the following paper:

"MY LORD SPENCER AND GENTLEMEN: We have ventured to ask this conference of you to-day in order to call your special attention to this, the third report upon contagious pleuro-pneumonia, recently issued by the Department of Agriculture of the United States, and to the fact that the conclusions arrived at therein are at variance with those of your inspectors.

"In order that a more thorough understanding of this difference of opinion may be reached, we respectfully ask that the question may be reconsidered.

"For this purpose specimens of condemned lungs, upon which this report is based have been brought to London, and we respectfully ask leave to submit them to you, or to experts selected by you, at any time and place that may be most convenient. And we further hope that you will allow us, together with these same gentlemen, to examine the lungs of any Western cattle now coming to Great Britain from the ports of Boston or Portland, which may be condemned by your inspectors as affected with contagious pleuro-pneumonia. As the Government of the United States have undertaken to carry out measures which must eventually result in the extermination of the disease, and hope before long to be able to show a country entirely free from this scourge, it is of the utmost importance that the finer appearances of the disease should be clearly recognized; for even after the country is entirely free it is very possible that lungs may be found from time to time, similar to those condemned last summer, that present grossly the appearance hitherto ascribed to contagious pleuro-pneumonia, but which, in reality, result from chronic inflammatory processes entirely unconnected with contagion. And these appearances, unless the authority of precedent is corrected, might cause insurmountable restrictions to be imposed."

Following the reading of this paper, questions were asked by his Lordship and other members of the council present, which developed the fact that the Department of Agriculture had already established throughout the infected district a corps of inspectors, all of them veterinarians of experience with pleuro-pneumonia, whose duty it was to know and report to their department the location and numbers of diseased herds, their movements, and the movement of all calves from among them; that Mr. L. McLean, M. R. C. V. S., had, in its interest, traveled extensively through the West, visiting all of the Iowa, Missouri, and Illinois herds, among which it was at one time reported, by irresponsible persons, that the disease had been introduced by eastern calves; that he had visited all of the large stock yards from Kansas City to Chicago, many of the large feeding stables in and about the larger cities of the West, and certain other isolated herds; in fact, that all intimations coming to the knowledge of the department which seemed to indicate in any way that pleuro-pneumonia might have an existence in the West or anywhere outside of the known infected district, had been and would continue to be thoroughly investigated. As yet no such disease had been found; in the event of its making its appearance in any new locality, most certainly the department would have and make public early and positive information concerning it. That I could, as a result of these examinations, together with much reliable information gleaned from other sources, most emphatically state that pleuro-pneumonia had no existence in the West, or along certain lines of rail leading to Boston and Portland, or in or about these ports, nor did I think it possible that calves from diseased herds could go West without the fact being known to inspectors of the department.

As a result, both our requests were very cordially granted; the question was ordered reopened and the Veterinarian-in-Chief was directed to examine, with us, both the specimens of last summer's condemnation that we had brought with us, and the lungs of any of the designated animals that might be condemned during our stay in that country.

On June 28 we called by appointment upon Professor Brown with specimens from *all* of the lungs that were condmned for pleuro-pneumonia at Liverpool, during my stay there last summer.* These were carefully examined by Professor Brown, who said that before giving an opinion he should very much prefer that the whole pathological part of the question should be gone into by Professor Yeo, pathologist at King's College, and that he would arrange that we meet the professor for this purpose as soon as possible.

As a result of this desire, on July 7 we visited King's College, where we met Professor Yeo, who, after a rather hurried examination of the specimens, said he would not absolutely say that these changes were due to contagious pleuro-pneumonia; he could only do so in any case after seeing the *fresh* specimen, as he considered it impossible to make an absolute diagnosis without noting carefully the entire relation of the diseased portions of lung to the healthy tissues of the same organ. He was rather inclined to the belief that there is no change resulting in the lungs of cattle, from either an acute or chronic inflammation, which may not be, so far as its appearances under the microscope are concerned, duplicated by the action of the disease known as contagious pleuro-pneumonia.

The only positive thing that he did state in relation to the specimens was that he considered the changes shown in them to be the result of a disease of at least two to three months' standing. Unfortunately for us during the whole of our stay, which was until the 16th of August, no condemnations for pleuro-pneumonia were made, therefore we could not furnish to Professor Yeo the fresh specimens demanded, and the matter, so far as he was concerned, ended here.

Before we left, Professor Brown assured me that he did not think there need be any occasion for alarm in the future; *that if our country was entirely free from pleuro-pneumonia*, no condemnations would be made upon lungs presenting the appearances only of those that were condemned in my presence last year.

The following tabulated statement contains the particulars of all of the condemnations of American animals for pleuro-pneumonia that have been made in Great Britain this year, so far as I am informed. If others are to be added they have arrived there since August 16:

Name of steamship.	From port of—	To port of—	Date landed.	Number condemned.
			1881.	
Milanese	Boston	London	Jan. 4	4
Greece	New York	London	Jan. 12	5
Utopian	New York	London	Jan. 13	2
Schleswig	New York	London	Jan. 16	2
Assyrian Monarch	New York	London	Jan. 19	12
Rochester	Boston	London	Jan. 28	2
Australia	New York	London	Jan. 29	1
City of Bristol	New York	Liverpool	Feb. 1	1
Minnesota	Boston	Liverpool	Feb. 4	1
France	New York	London	Feb. 9	1
Sumatra	Boston	London	Feb. 27	1
Edinburgh	Boston	London	Apr. 15	4
Devon	New York	Bristol	June 16	1

Making a total of 37 animals from January 1, 1881.

Of these there were condemned in London from New York 23; London from Boston, 11; Liverpool from New York, 1; Liverpool from Boston, 1; Bristol from New York, 1.

There were landed in Liverpool, from January 1 to August 12, 30,310 cattle, from which 2 only were condemned. Exactly what number were landed in London and at other British ports during this time, I have as yet been unable to ascertain; but during the six months ending June 25, 1881, there were landed in Great Britain from the United States 56,721 head. This would make at all the other ports except Liverpool, during the six months, about 32,000 animals, of which 1 was condemned in Bristol and 34 in London, as suffering from contagious pleuro-pneumonia.

In this connection I feel it my duty to report to you as a result of my two seasons' inspections in England, that while the governmental examinations at Liverpool are conducted so carefully and methodically that there is no danger of a wrong credit being given for a case of disease found, there is, in my opinion, every chance that in London a diseased lung found in the slaughter houses at Deptford foreign animals market, may be returned as coming from a port in the United States through which the animal never passed; or even that an animal landed there from France or other European country, the lung of which is condemned as showing lesions of pleuro-pneu-

* See Senate Ex. Doc. No. 5, 46th Congress, 3d session, p. 9.

monia, may be returned to the Privy Council Office as coming from the United States, or *vice versa*.

On the 20th of July last, in the course of a conversation on this point, the inspector at Deptford stated to me that his method for detecting pleuro-pneumonia was when he did not diagnose it in the living animal (and he acknowledged that his accommodations for such examinations were inadequate) to have all the lungs reserved and afterwards examine them carefully, and when a nodule of any kind was discovered to cut down upon and examine it critically. He further remarked that when he found a diseased lung and had not previously condemned the animal, *there was scarcely any mark upon the carcass by which diseased animal could be identified*. When asked how he reported such a case to the Privy Council, he said he simply reported it as one case of pleuro-pneumonia. To the further question as to what country, or what cargo the diseased animal was credited, whenever animals from two or three different countries or ports were being slaughtered by the same person at the same time, as was very often the case, he answered that *he never had any difficulty in identifying the animal*.

As a result of my conference with the authorities of Great Britain upon this subject, I think it may safely be stated that the impressions which they held regarding the health, in this respect, of our Western herds have been materially changed, and that lungs having a certain appearance, heretofore condemned as being that of contagious pleuro-pneumonia, will not be so considered in the future.

Still the fact remains that we, as a country, are not free from this disease, that it continues its ravages to some extent among the herds in a narrow strip of country extending from about New York City to and including the District of Columbia, and the district about Alexandria in Virginia, and that so long as this state of affairs is allowed to exist it will be impossible to obtain any relief whatever from the present burdensome restrictions placed upon all our cattle going to Great Britain. Nor shall we in any way be able to prevent the ultimate spread of the disease to our Western herds, and their consequent destruction, unless restrictive measures are at once adopted.

As a remedy against present loss and future danger from this source, I cannot do better than to ask your consideration of my recommendation of last year, viz: Let Congress enact such measures, and authorize such an execution of them, as shall immediately restrict the movement of cattle out from and within infected districts, and in time eradicate every case of lung plague.

Inasmuch as there are at present two very important questions, both of them having a very material bearing upon the methods to be adopted for ridding a country of pleuro-pneumonia, I would suggest the propriety of undertaking, in addition to the present work of the division, a plan of experimental study with a view of ascertaining:

1st. Whether pleuro-pneumonia contagiosa can be communicated in any way except by actual contact of the healthy with the diseased living animal; and

2d. Whether or not unprotected animals can safely be introduced into a stable in which the disease has formerly existed, but into which no animal but those that have been properly inoculated and have recovered have been allowed to enter for some time, and in which it is known that the disease in its pure form has not existed for at least six months.

There is very much that might be said upon these two questions, but probably the statement will be sufficient here that high English authority, including that of the privy council, assert an unbelief in the mediate contagion theory of spread, while other and perhaps as good authority both in England and in the United States say that their own actual experience causes them to hold opinions exactly the reverse.

In regard to the second proposition, while the practice of preventive inoculation is by no means new, it is a fact that recently its management has seemed to be better understood in some ways, and the results of its systematic practice in the Netherlands and in certain parts of Great Britain, as well as upon isolated diseased premises within our own districts seem to show a rather easy way of possibly ridding ourselves of the scourge, especially in our larger infected city dairies. While such eminent authority as Fleming asserts that it can be done, the fact still remains that no country has as yet, in this way, rid itself of the plague.

FOOT-AND-MOUTH DISEASE.

In January of this year the Veterinary Division of the Department of Agriculture was notified by the Veterinary Department of the Privy Council that 59 cattle affected with foot-and-mouth disease had been landed at Deptford (London) from New York by the steamship France. This warning was followed in a few days by a notification that at the same place 267 cattle from the steamer City of Liverpool, from New York, had been similarly condemned. These notifications continued to arrive at frequent intervals, all of them relating to condemnations made at London, until on March 23, with the condemnation of 371 cattle from the steamship City of Liverpool, the manifestations of the disease among our animals at this port stopped as suddenly as it had begun.

In the mean time, however, notice had been received that on the 17th of March the disease had been found at Liverpool, when, on that day, 208 animals from Portland, by the steamship Lake Manitoba, were condemned as suffering from it. From this time, notably on May 11, when 694 such condemnations were made from the cargo of the Iowa, from Boston, until June 9, notices of its arrival at this port continued to be received, when it subsided as suddenly as it had done at London, with the condemnation of 137 animals, by the steamship Istrian, from Boston. Before this desired end was reached, however, notice had been received that a cargo had been landed at Glasgow from the steamship Phœnician, from Boston, among which 235 bullocks suffering from foot-and-mouth disease had been condemned. Here its appearance began and ended with the landing of this cargo.

Immediately upon the receipt of this information, means were undertaken which it was hoped and supposed would lead to the source of this new and threatening danger. Careful inspections of animals going abroad were made at the ports of debarkation; certain cattle that had been condemned upon reaching England were traced to the Eastern yards and from thence to Chicago, to which place Mr. McLean, M. R. C. V. S., was sent. From there he successfully traced them on to other stock yards, and in a number of instances even into the stables where they had been feeding for weeks; notwithstanding all of which, no indications of the presence of the disease could be discovered. This being the unsatisfactory state of affair at the time it was determined to send a representative to England in connection with the pleuro-pneumonia inquiry, the added instruction was given me as already detailed, in the hope that some solution of the problem might be reached.

Therefore, upon landing in Liverpool, and before proceeding to London, I at once visited the wharves upon the Birkenhead side of the river, upon which animals from the United States are landed. Here I found but few cattle, and they appeared to be in a perfectly healthy condition. Great precautions had been taken to render the buildings and premises free from the contagion of foot-and-mouth disease; small brick furnaces, in which sulphur had been burned, were placed within short distances of one another in the buildings; a very large quantity of strong lime-wash, in which, I was told, had been disolved 20 per cent. of crude carbolic acid, had been used upon all the walls of the buildings, both inside and out; also upon all runs, fences, outbuildings, &c., about the place, small boxes had been arranged into which, before being allowed to leave the inclosed premises, all men that had been in contact in any way with the condemned animals were obliged to go and receive a thorough fumigation. These sanitary and preventive measures were established by the inspector, Mr. Moore, F. R. C. V. S., and were carried out in a most thorough and praiseworthy manner.

As no disease offering opportunity for examinations existed here at this time, I decided to go immediately to London and there ask permission of the proper authorities to prosecute my investigations upon premises under their control. During the meeting with the council on June 27, to which I have referred in the report upon pleuro-pneumonia, some conversation regarding the landing of foot-and-mouth disease took place, and in answer to questions put to me by Lord Spencer I stated that so far as I knew and believed, and that much time and effort had been used to demonstrate the truth, the disease had no existence among the animals in the United States. This, of course, surprised them, and they were at as great a loss as myself to account for its appearance, and immediately offered to do all in their power to help ascertain the facts. Afterwards I told Professor Brown that if he would send an inspector with us, that we might together investigate the matter, I should be glad to have him do so. This proposition, however, he failed to accept.

At the Veterinary Department I was furnished a list of the names and dates of landing of all the steamers from which American animals had been condemned as suffering from foot-and-mouth disease upon arrival, as follows:

Name of steamship.	From port of—	To port of—	Date of landing.	Number condemned.
			1881.	
France	New York	London	Jan. 1	59
City of Liverpool	New York	London	Jan. 6	267
City of London	New York	London	Jan. 18	12
Rochester	Boston	London	Jan. 28	42
France	New York	London	Feb. 9	56
Faraday	New York	London	Feb. 13	339
Greece	New York	London	Feb. 23	23
Lake Manitoba	Portland	Liverpool	Mar. 17	208
City of Liverpool	New York	London	Mar. 23	371
Palestine	Boston	Liverpool	Mar. 27	186
Lake Nepigon	Portland	Liverpool	Apr. 7	112
Iowa	Boston	Liverpool	May 11	694
Phœnician	Boston	Glasgow	May 31	235
Istrian	Boston	Liverpool	June 9	137
Total				2,742

I concluded to begin this investigation by calling upon the owners, or those representing the various steamers from which condemned animals had been landed. At the office of the National Line, represented in the above list by the France and Greece, the statement was made that all of the vessels of this company upon arriving at the port of London with cattle transship them some distance down the river on to a tender, which takes them from there to Deptford. Sometimes this change is made in the stream; at others the transport boat goes with the vessel into the dock, in which case there must be a detention of at least one tide. These transport boats are provided by the London General Steam Navigation Company under contract to the Veterinary Department of the Privy Council; they are of good size, and there is never more than one provided at a time, although at various times there have been a number of different ones used. It is understood that this tender is thoroughly disinfected between each cargo.

STEAMSHIP FRANCE—FIRST DISEASED CARGO.

The vessel on her outward trip sailed from London on November 27, 1880, having among her cargo manufactured goods only. On the homeward voyage she arrived in London January 1, 1881. The animals were transshipped without delay, and although no one on board had any knowledge of the existence of disease among them, there were condemned, four hours after landing at Deptford, 59 head as affected with foot-and-mouth disease.

STEAMSHIP FRANCE—SECOND DISEASED CARGO.

This ship sailed again from London January 7, having among her cargo 21 bales Marseilles wool, 2 bales goat skins, 11 bags English wool, 32 bales of skins from Bombay, 15 casks of salted skins from England, 50 bales unwashed Australian and 200 bales Russian wool. This wool was stored in No 1 orlop and No. 5 steerage deck (she also carried two bulls and eight heifers, consigned to the "American Horse Exchange, Limited," in New York, when upon arrival, January 21, 1881, they were found to be affected with foot-and-mouth disease and quarantined for 90 days.) On her return trip all cattle were carried on the main deck. She arrived in London again on February 9, when the following telegram was received from the captain: "France arrived at 12 o'clock; lost 18 cattle on the voyage." She was not docked until 10 o'clock next morning. Upon the examination of the cattle at Deptford, 56 head were condemned for foot-and-mouth disease.

STEAMSHIP GREECE.

This vessel sailed from London on her outward trip January 20, 1881, having among her cargo 1 bale rabbit skins, 30 bales raw skins, 23 bales dry English skins, and 50 bales Russian wool. This wool was stored in the steerage where the cattle were carried on the return voyage. She arrived back on the 23d of February, and the captain telegraphed: "Arrived at 2.45 p. m., and cattle now going out." Upon being examined at Deptford 23 head were condemned for foot-and-mouth disease.

Because these vessels dock some distance down the river, it is believed that no head-ropes, grain-bags, pails, or other articles used about the cattle during the voyage, and which are all landed with them at Deptford, under the law, are reshipped, as the expense of transportation and dockage rates would be very high. The cattle fittings are all retained, but are thoroughly disinfected after each voyage. No live cattle have ever been carried as stores. The presence of the disease had never been "logged." Mr. Brooks, visiting agent for the company, was very sure that none of the disease in question had been noticed on any of their boats. At the time the France had landed her second "diseased" cargo, he had gone to Deptford to see the cattle, and found them sick, as he was told, with foot-and-mouth disease; that they were sick he was satisfied. Just afterward (February 23), on the arrival of the Greece, he went on board and made a careful examination of the animals in company with the first officer and Mr. Pilling, representing the consignee, Mr. Bell (who had come to the steamer especially for this purpose), and the head cattleman. As a result, they all agreed in declaring that there was no sickness whatever among them.

Captain Pierce, of the Greece, said that he did not notice any disease among the cattle on this voyage; it is his habit during a voyage to go below and among the animals. Whenever cattle die on board he logs the fact; he has never logged an outbreak of sickness because he has never yet had one.

We next called upon Messrs. William Ross & Co., agents of the City Line, represented in the list by the City of Liverpool and City of London. These steamers never go to Deptford, but tranship their cattle in precisely the same manner as do those just described.

STEAMSHIP CITY OF LIVERPOOL—FIRST DISEASED CARGO.

This vessel sailed from London on the outward voyage November 28, 1880, having among her cargo 5 bales wool, 18 tons salted hides, and 19 bales dry skins. On the homeward voyage she arrived in London January 6, 1881. The cattle were transshipped at once; of these, after being landed at Deptford, 267 head were condemned as suffering from foot-and-mouth disease.

STEAMSHIP CITY OF LIVERPOOL—SECOND DISEASED CARGO.

On this voyage the ship sailed from London February 11, 1881, having among the cargo 22 tons salted hides and skins, 5 bales wool, 214 bales "greasy" wool (probably Australian), and 12 bales skins.

On the homeward voyage she arrived in London on March 20, when, because the steamer had not been telegraphed from Gravesend, there was no transport ready to receive the cattle, she therefore docked with them still on board, and it was not until the second day after that they were transshipped, and on the 23d, 371 head were condemned as suffering from foot-and-mouth disease.

STEAMSHIP CITY OF LONDON.

This vessel on her outward trip sailed from London December 11, 1880, having among her cargo 35 tons salted hides, 4 tons salted skins, and 2 tons dry skins. On the homeward voyage she arrived in London January 17, 1881, where, on account of the state of the tide, and to save time, the transport accompanied her into the dock, as is very often done under such circumstances. This caused so much of a delay that the animals were not examined until the next day, at which time 12 head were condemned as suffering from foot-and-mouth disease.

These vessels have never carried any live stores, nor have they, so far as known, ever carried back to America any head-ropes, bags, pails, &c., that had been in the Deptford lairages. The cattle fittings are permanent, thoroughly disinfected after each voyage, and whenever repairs upon them are needed it is done in America, and with lumber procured there.

We next saw Messrs. Adamson & Ronaldson, who made the following statements regarding steamers under their control:

STEAMSHIP ROCHESTER.

This vessel, on her outward voyage, sailed from London on December 8, 1880, having among her cargo 131 bales of wool (probably Australian unwashed). On her homeward trip, after a long and stormy passage, she reached London January 28, when, at a considerable distance down the river, the cattle were put on board the transport boat. This was not the common practice, but was in fact the only time she had not gone alongside at Deptford to discharge. Upon being examined, all that were left of the original shipment, viz., 42 head, were condemned as suffering from foot-and-mouth disease. Concerning this shipment I was told that the animals, before going on board, were detained on the railroad four days over time by snow-storms, during which they were probably neither fed nor watered. Upon reaching Boston they went immediately on board ship; seemed very tired and laid down *at once*; shortly after, two died; soon they commenced dying in large numbers, and the carcasses were thrown overboard. Owing to the unprecedented roughness of the passage, the cattle arrived very much bruised and exhausted, and, in the opinion of the owners of the vessel, this was the only cause for their condemnation. The practice of the steamers of this line is to go alongside the landing stages at Deptford and discharge the cattle direct, simply because it is convenient for them to do so, as they berth at the Millwood docks, which are just across the river. They never carry any live stores, and the cattle fittings are put up at Boston, and when repairs are necessary they are made there. When asked if they ever carried back to America any head-ropes, bags, &c., from the premises at Deptford, they at first said "No," but, upon looking into the matter, found that the steamer Milanese, sailing from London October 2, 1880, the steamer Sumatra, sailing from London June 16, 1881, the steamer Housa, sailing from London June 27, 1881, had done so, and they now thought it more than possible that upon other occasions other steamers had carried to Boston bundles of such ropes, which had been brought to the ships by watermen's boats directly from the Deptford lairages.

STEAMSHIP FARADAY.

This vessel is owned by the Messrs. Siemen Bros., but at the time of the voyage in question was chartered to Messrs. Adamson & Ronaldson. In 1878 she was employed in carrying cattle; later she was engaged in laying telegraphic cable and, towards the close of the year 1879, she was laid up in Millwood dock, where she remained empty for more than a year. She had carried live stores while laying cable, but not when engaged on these other voyages.

The cattle fittings were put up partly while she was in Millwood docks, and partly during the outward voyage, of lumber obtained in England; she has never carried any provender, head-ropes, pails, or grain-bags. This vessel on her outward trip sailed from London in November, 1880, with a cargo among which were 2,848 bales of Russian wool loaded into the tanks, at the bottom of the vessel, generally used for storing the cable. The combings of the hatches are raised about 4 feet above the level of the docks, so that it was thought if a bale had been broken while being hoisted out the wool would have fallen back into the tank, and not have been scattered over any of the decks upon which cattle were afterwards carried. Going into New York, when off Sandy Hook, she broke her propeller, and was obliged to lay up in Brooklyn for several weeks before taking on board her live cargo, which she did at the Henderson docks in New York. The passage home was a very long one, some twenty-one or twenty-two days, and it was not until the consignee of the cattle, Mr. Bell, or his agent, went on board the ship upon her arrival home that there was thought to be any disease among the cattle; he, however, discovered it then. She went alongside the landing stage, at Deptford, on February 13, and discharged her cattle, from which were condemned 339 head as suffering from foot-and-mouth disease.

STEAMSHIP LAKE MANITOBA AND S. S. LAKE NEPIGON.

Although the representatives of the Beaver Line, to which both these steamers belong, were personally seen, they, for their own reasons, preferred to answer my questions regarding them by letter, as follows: "In reply to your inquiries as to cattle by the above steamers from Portland, Me., arriving here on the 16th March and 7th April, 1881, I have to inform you that 208 head were landed affected with foot-and-mouth disease from the Lake Manitoba, and 113 head from the Lake Nepigon. The outward cargoes by each steamer were the usual general cargoes, and contained no hides, skins, head-ropes, pails, &c. The disease did not develop during the voyage sufficiently to come under the notice of the captain and officers of the steamers, and no entries were made in the log-book respecting it. On the voyage in question the Lake Manitoba left Portland the 5th of March, and the Lake Nepigon the 22d of the same month, but had no live stock on ship's account on board. The shippers of the cattle were Messrs. R. Craig & Co. and D. H. Craig, ex. Lake Manitoba; Messrs. R. Craig & Co. and D. H. Craig, ex. Lake Nepigon."

Calling upon Messrs. George Warren & Co., representatives of the steamers Palestine and Iowa, I received the following information:

STEAMSHIP PALESTINE.

The steamer left Liverpool on her outward voyage February 24, having among her cargo 4 casks skins. Although there was no mention of there being any head-ropes, &c., on board, I was assured that possibly there might have been some, as they often take them. On the homeward voyage she left Boston March 12, and arrived in Liverpool and discharged her animals by going alongside the landing stage (as all vessels do at this port) on the 27th of March, when 186 head were condemned as suffering from foot-and-mouth disease.

STEAMSHIP IOWA.

This vessel on her outward voyage left Liverpool April 12, having among her cargo 4 casks wet skins, 328 bags hide cuttings, 4 *bundles corn-bags and* 4 *bundles head-ropes from the lairages to R. Craig & Co.*, 83 coils old rope, 500 salted hides, 21 bales dry hides, and 125 bags Yorkshire wool. She left Boston on the homeward trip April 30, at noon, with about 849 cattle shipped by Thomas Crawford & Co., S. W. Clark, C. M. Acer & Co. (which, the gentlemen remarked, is the same as Craig), R. Craig & Co., John S. Fraser, D. Coughlin, F. R. Lingham, and T. and F. Uttey. The first disease, said by one of the cattlemen to be foot-and-mouth, was, says the ship's log, noticed at 8 a. m. on the 6th of May, among animals belonging to C. M. Acer & Co., on the port side of the after steerage; on the 7th of May, at 8 a. m., the same trouble was showing among cattle by the forward hatch, belonging to R. Craig & Co.; on the 9th, at 4 a. m., it was discovered among other cattle occupying space in the after steerage, forward steerage, main deck, and starboard alley-way; on the 10th, at 4 a. m., it is recorded that foot-and-mouth disease is still spreading among the cattle all over the main deck, and on the 11th of May, at 6 a. m., at which time they were landed in Liverpool, the disease had spread throughout the ship, and 694 head were condemned as being affected with the disease.

The Iowa has never carried to America from England any cattle, calves, sheep, or pigs; neither do any vessels of this line carry live stores. The cattle fittings are put in and repaired at Boston.

STEAMSHIP PHŒNICIAN.

This vessel is of the Allan Line, and of that division of it having its headquarters at Glasgow. From the firm there I have the following information concerning her: On the two previous voyages, that is, since the 20th of September, 1880, she was employed in the River Plate trade, where she carried no cattle. Upon the outward trip, of the voyage in question, she had simply the ordinary general cargo, not having among it any articles that could with reason be supposed to have been in any way in contact with diseased animals of any kind. On the return voyage she left Boston at 1.45 p. m., on the 17th of May. The cattle, 239 head in all, were shipped by J. McShane, jr., of Montreal. The first symptoms of sickness among them were noticed three days after the vessel had left port, "on an old bull;" from him the infection speedily spread through the rest of the cattle, until, upon the 31st of May, when she landed them at Glasgow, 235 head were condemned as suffering from foot-and-mouth disease. Her cattle fittings were put in and all repaired in Boston. She did not carry any live stores, nor was there anything about her which could have given rise to the disease. In a letter on the subject the Messrs. Allan say, "We are satisfied that the ailment originated with the old bull, and was brought from America; he, however, had recovered before the end of the voyage."

Concerning this shipment, I had learned early in June, from the Messrs. Allan, at Boston, that of the 239 animals shipped on this vessel by Mr. McShane, six car-loads, consisting of 103 head, were Canadian cattle, and 137 head were Western States *steers*. These *steers* were bought of Munroe, of Brighton (Boston), and the lot was made up as follows:

Thirty-head lot, averaging 1,331 pounds, bought of R. Strahom & Co., Chicago, May 7.

Thirty-seven head, of a lot of 127 head, averaging 1,302 pounds, bought of R. Strahom & Co., Chicago, May 7.

Sixteen-head lot, averaging 1,400 pounds, bought of R. Strahom & Co., Chicago, May 7.

Five head, of a lot of 30 head, averaging 1,224 pounds, bought of Reynolds, Enoch & Co., Chicago, May 7.

Four head, of a lot averaging 1,685 pounds, bought of Robinson, Chicago, May 7.

Forty-five head, of a lot of 82 head, averaging 1,329 pounds, bought of Daly, Miller & Co., Saint Louis, May 6.

Giving the total of 137 animals, making, Mr. Munroe assured me, a nice straight lot of steers.

I afterwards learned that Mr. McShane had frequently shipped cattle to Liverpool during the existence in the lairages there of foot-and-mouth disease, and I was told by another shipper, who has had more or less to do with him, that it was McShane's practice, as well as that of nearly all exporters, to bring back and use their old head-ropes.*

STEAMSHIP ISTRIAN.

I am indebted to Messrs. Frederick Leyland & Co., the owners of this steamer, for the following particulars: She left Liverpool on the outward voyage May 12, having among her cargo 9 bales wool waste, 2 bales hair, 3 casks salted skins, 350 bundles salted calf skins, 272 coils old rope, 31 bales wool, 11 casks salted skins, 868 wet salted hides, 3 bundles calf skins, and 259 bales wool. On the homeward voyage she left Boston on the 29th of May. Although the log makes no mention of any disease among the cattle, it does mention in several instances sickness and death among the sheep on board, which fact carries the inference that had anything wrong been noticed with the cattle, it, too, would have been "logged." She discharged the cattle in Liverpool at 4.40 p. m., June 9, when 137 head were condemned as having foot-and-mouth disease. The sheep were not mentioned as being affected.

This vessel, as well as others of this line, have frequently carried back head-ropes; they are brought from the lairages and taken charge of during the voyage by the servants of the owners of the cattle who return upon the steamers.

The shippers of the cattle were Messrs. Swift Bros. & Co., and Messrs. J. and C. Coughlin, who are regularly engaged in the trade between Boston and Liverpool. Afterwards, in an interview with one of the Messrs. Coughlin, I learned that their practice was to collect their head-ropes in the lairages and reship them for use in America, and that he would rather use a new rope with every animal than have this disease appear among them, and he thought other shippers entertained the same views.

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* James McShane, jr., shipped cattle from Boston to Liverpool as follows; January 27, 177 head, on the Pembroke; February 18, 100 head, on the Glamorgan; February 23, 80 head, on the Pembroke; April 6, 130 head, on the Pembroke; April 13, 175 head, on the Glamorgan.

The investigations so far seemed to point to the fact that from whatever source the infection had reached the American animals, the vessels themselves, in their general cargoes and management, should be held blameless, and that notwithstanding a few instances in which its appearance might reasonably be due to other causes, notably in the second cargoes of the steamers France and City of Liverpool, the outbreaks were directly chargeable to the self-same infection that had already caused so much trouble in Great Britain, conveyed by the indiscriminate use of the head-ropes, &c., coming from the foreign animals' wharves at Deptford and Liverpool, which were, at that time, hotbeds of the disease. It remained, then, to ascertain how these premises became infected; how this infection could have been conveyed to these articles; how they, having become impregnated with the virus, could have come in contact with the cattle in such a way as to cause the outbreaks which undoubtedly had taken place in mid-ocean, and not at the same time have been introduced to our various seaboard markets.

INTRODUCTION AND SPREAD OF THE DISEASE IN THE DEPTFORD MARKET.

In the report of the Veterinary Department of the Privy Council office for 1880, Professor Brown writes:

"In the middle of September last, the inspector of the Privy Council at Deptford had his attention called to the existence of the signs of foot-and-mouth disease in the tongues of some French cattle which had been slaughtered in the market; no symptoms of the disease had been seen in the animals during life, but the morbid appearances were characteristic, and left no room for doubt as to the nature of the infection. Soon afterwards, on September 20, a cargo of cattle from Havre were landed at Deptford from the ship Swallow, and on inspection the second day after landing some of them were found to be affected with foot-and-mouth disease.

"The disease thus introduced into Deptford foreign-cattle market continued to spread among the animals which were landed there, and as the lairs at that time were overcrowded with animals from America as well as from Europe, no opportunity was afforded for the effectual disinfection of the places where disease had existed, and consequently animals which were perfectly healthy on landing became infected soon after entering the lairs."

From the assistant inspector, in relation to the same matter, I have it that "foot-and-mouth disease was brought to Deptfort by the steamship Swallow from Havre, September 20, 1880; she had on board fifty-seven cattle, thirty of which were affected with the disease; other cargoes with foot-and-mouth disease were landed at Deptford, from France, November 8 and December 17, 1880."

In a conversation upon the subject, the inspector of the Privy Council at Deptford said to me that if he remembered rightly their first real trouble was during the latter part of September, 1880, and was caused by some animals coming from France; from these, foot-and-mouth disease spread over the entire premises. From that time onward it had caused them much trouble, and they have taken a number of extra precautions as to disinfecting, and so on. He further said that upon going into the lairages animals are necessarily greatly mixed, and in a number of instances he remembered that there had been cattle landed from the United States in a healthy condition which had afterwards contracted foot-and-mouth disease on these premises through coming in contact, either directly or indirectly, with those from other countries already diseased. Alterations were then under *consideration*, which, when carried out, it was hoped would overcome this evil. The lairages were not then (July 20) nearly as badly infected as they had been, but still it was not improbable that even then some of the infection might remain about the premises; in fact, quite recently he had discovered its existence in animals that had been landed healthy, and that could have contracted it only from their contaminated surroundings.

INTRODUCTION AND SPREAD OF THE DISEASE IN THE LIVERPOOL MARKETS.

The history of the introduction and spread of foot-and-mouth disease into and through the Liverpool lairages is in some respects remarkable, and inasmuch as it has never yet, to my knowledge, been given publicly, it will, perhaps, be worth while to give it here at length. For my ability to do so I am greatly indebted to Mr. Moore, the local inspector of the Privy Council, whose exact methods of preserving the various data in connection with his inspections were invaluable to me in this case.

Very early in January, 1881, the steamship Brazilian, bringing cattle from Boston to Liverpool, upon entering the river Mersey, grounded, and in trying to get off became disabled to such an extent that it was found to be necessary to take the cattle from her where she lay. Engaged in this work were several small boats, as follows:

January 4—	Head.
The tug Cruiser brought up	111
The tug Wrestler brought up	111
The tug Rover brought up	65

	Head.
The tug Knight Templar brought up	53
The tug Knight of Malta brought up	33
The tug Fury brought up	1
The tug Republic brought up	3
Ferry-boat Sunflower brought up	224
Flat-boat Mersey brought up	32
The tug Lord Lyons brought up	1
The tug Ajax brought up	4
Flat-boat Mersey (2 cargoes) brought up	24
Mudhopper B brought up	2
Crane barge Ironsides brought up	1

In all, 665 animals were thus landed at the Woodside lairage. There were ten others landed, part at Wallasey and part at Huskisson No. 2 lairages, and one swam ashore and was killed on the beach. Of the health of these animals, Mr. Moore says: "I examined them all on the 5th and found them free from disease. On the 9th a bullock, one of those landed at Woodside, was found sick. He was slaughtered, and the *post-mortem* examination revealed recent foot-and-mouth disease. There were vesicles in the mouth and on the tongue, but none on the feet. On the 10th three cases more were discovered in the same lot, and on the 11th two more were found." It seems that these animals, as soon as the disease was discovered, were killed very quickly, for, while at midnight of the 8th 452 of them were still alive, there were on the 11th but 9 head remaining. This probably accounts for the fact that no more cases were discovered among them. On the morning of the 11th the premises with the remaining 9 animals were locked up, and no one but the attendants allowed to enter. The animals were quickly killed, and disinfection of the place they had occupied commenced.

There were on the other half of the wharf 8 bulls remaining from a cargo of 32 animals landed healthy on the 7th of January, from the steamship England, from New York. On the 10th, or eight days after the Brazilian outbreak was first noticed, 4 of these were found diseased. They were killed, the premises disinfected, and the wharf was not again used until after January 29. It could not be ascertained to be a fact that any of the boats engaged in this transshipment, except the Mersey, were in the habit of carrying home-cattle about the river. She undoubtedly was, and there was also some little indication that the ferry-boat Sunflower had done the same thing. To one of these two boats then conveying infection contracted from English animals, previously carried, to those brought by it from the disabled steamer, must be ascribed the honor of introducing foot-and-mouth disease into this lairage, for, when the history as related is considered, and when it is remembered what a short time is necessary for its incubation, any other explanation of the occurrence seems impossible.

Nothing more was seen of foot-and-mouth disease here until on the 17th of March, more than two months afterward, the steamship Lake Manitoba, from Portland, landed a cargo of 259 head, among which were found 208 cases. They were landed at Woodside, and were all slaughtered by the 19th. The portion of the wharf occupied by them was disinfected and closed up, remaining so until the 29th.

On the 27th of March the steamship Palestine landed at Wallasey 240 oxen, among which were 186 cases of foot-and-mouth disease. They were all slaughtered by the 29th, and the wharf was closed for eleven days.

On the 7th of April the steamship Lake Nepigon, from Portland, landed at Woodside 141 oxen, among them 113 cases of the disease. All of these were soon slaughtered and the wharf closed for a time. On May 11 the steamship Iowa, from Boston, landed at Wallasey 859 oxen, among them 694 cases of the disease. All of these were slaughtered by the 16th, and the wharf was closed from then until the 31st. On the 9th of June the steamship Istrian, from Boston, landed at Woodside 371 oxen, among which were found 137 cases of foot-and-mouth disease. These were slaughtered by the 19th, and the wharf was closed until the 3d of July.

Regarding the spread to healthy animals in the buildings, Mr. Moore made to me the following statement: "On January 4, oxen ex. steamship England, from New York, were infected in the Woodside lairages by the Brazilian lot. Oxen which were landed healthy from the steamship Canopus on the 23d, from the steamship Pembroke on the 20th, and from the steamship Bavarian on the 22d, were found on the 27th of April to have contracted the disease. The steamship Illyrian, from Boston, landed her cargo of 346 oxen on the 26th of April, all healthy. These animals were examined carefully every day, and on the 30th foot-and-mouth disease was found among them.

The steamship Lake Manitoba, on the 27th of April, landed 338 oxen, all healthy. They were carefully watched, and the disease made its appearance among them on the 1st of May.

On the 28th of April the steamship Minnesota landed a cargo of 406 oxen, all healthy. On the 1st of May foot-and-mouth disease appeared among them.

On the 4th of May the steamship Massachusetts landed 565 bullocks, all healthy. They were examined every day, and on the 7th one case only had been discovered.

They were not "mouthed," and the butchers may have removed and killed cases that were not seen, but, so far as is known, only 16 of this whole lot became diseased.

On the 8th of May four cases were found among previously healthy cattle that had been landed from the steamship Ontario, May 4.

On the 9th of May foot-and-mouth disease was found among previously healthy animals that were landed on the 4th from the steamships Bulgarian and Palestine.

On the 11th of May, at 7.50 a. m., the steamship Iberian landed a cargo of 352 oxen. They remained healthy up to the 16th, when the disease was found to be among them.

On the 18th of May the steamship Toronto landed 251 cattle. The first evidence of the disease among these animals was observed on the 24th.

On the 26th of June six cases of foot-and-mouth disease were found among oxen that had been landed healthy from the steamship Palestine on the 17th. This infection was supposed to have been from the cargo of the Istrian, which landed the disease on the 9th of June.

GLASGOW.

From any information that is at present in possession of this Department, I think that it can scarcely be said that the premises at Glasgow have ever become infected, for, although it is true a cargo of condemned animals from the steamship Phœnician were landed there, they were so quickly killed and the premises so thoroughly disinfected that it seems not to have gained any foothold. The appearance of the diseased cargo there seems to be entirely explained by the evidence already given.

Mr. McShane, the shipper, had 130 cattle on the steamship Pembroke, which left Boston for Liverpool on the 6th of April. The Pembroke landed all her cattle in a perfectly healthy condition in Liverpool on the 20th of April; on the 27th, however, they were unfortunate enough to contract the disease in the Woodside lairages. Twenty days afterward, or on the 17th of May, we find Mr. McShane making a shipment of 239 cattle on the steamship Phœnician, from Boston to Glasgow, from among which, upon her arrival at that port, 235 head were condemned as suffering from foot-and-mouth disease. It is also in the evidence that Mr. McShane was in the habit, as were others, of bringing back and using again head-ropes that had done previous service upon animals in the contaminated Liverpool lairages.

It would seem, therefore, that the Phœnician outbreak is chargeable to infection brought direct from Liverpool. All cattle shipped from America to Great Britain are, after going on board the steamer, tied to stanchions by ropes which have been placed around the base of the horns, technically known as "head-ropes." Upon their arrival at the port of destination, the end that was made fast to the fixture on the vessel is untied, and the animals, with the ropes still hanging, are driven into the lairs, where they are to remain until taken out for slaughter. At Deptford these ropes are sometimes removed from the heads in the lairages when they are sold, at others they accompany them to the shambles. In Liverpool, so far as I have observed, they always remain on the animals until they are slaughtered. In this way every chance is given for their thorough impregnation with the virus of any contagious disease that may be present in either the lairs or the slaughter houses. To show how thorough this chance is I may say that in London I saw a lot of Dutch bulls tied "head on" to the same rail with a lot of American bullocks; also a lot of Spanish head-ropes hanging over a rail to which American animals were tied at the time; and in the shamble pens were some cattle with the original head-ropes on, some with ropes supplied by the butchers, and others without either, mixed indiscriminately with Spanish and Dutch cattle, all awaiting slaughter. In several instances the animals in one pen were tied facing those in the next, all to the same rail.

It was told by the inspector at Deptford that no head-ropes had been returned to America for two years, but I think he must have been mistaken in this, for not only were dates given me by the steamship owners, upon which they had received and shipped them, but on several occasions while at Deptford I saw large bunches of them hanging over the cross-rails, which, upon inquiry from the workmen collecting them, I was told were being got ready for reshipment to the United States.

At Liverpool, Mr. Moore assured me that old ropes were constantly returned, and that he, realizing the danger from such a practice, had done what little he could to prevent it. From inquiry and personal observation I find that as a rule cattle going abroad are "roped" either after the car load arrives at the dock, when a man goes into the car for the purpose, or else not until the animal has been driven from the car on to the steamer. To this fortunate circumstance, and for no other reason probably, is it that the animals in our home markets have so far escaped foot-and-mouth disease.

Although following the movements of contagion is, as a rule, not the most certain of all pursuits, it does seem as if this investigation into the causes of the appearance of this disease among some of our cattle landed in Great Britain during the past year had been attended with success, and that while certain dangerous practices are allowed in the matter of unsafe articles of import, such as unwashed wools, green hides, skins, &c., there is no one cause among them all sufficiently constant to be regarded with anything more than suspicion. On the other hand, the evidence plainly shows that to an article not looked upon or imported as cargo, but simply sent back to accommodate the cattle shippers, and used by them without a thought of danger, must be ascribed the cause of the outbreaks, and when the evidence is read the transmission of foot-and-mouth disease by the head-ropes seems so simple and easy of accomplishment that the wonder is that any one conversant with the practice of the trade need for a moment have had any doubt as to the true source of the infection.

To prevent future outbreaks of the kind I shall recommend for your consideration that Congress be asked to pass a law prohibiting, under certain penalties, the introduction of all articles from the foreign animals' wharves of Great Britain, and that custom officers be directed enforce such law.

TRICHINÆ IN SWINE.

In relation to that part of my instructions directing me to examine the hogs arriving in Great Britain from the United States, with a view of ascertaining to how great an extent they are diseased, or are infected with trichinæ, I have to report that during my stay no such animals were landed. But as tending to give some idea of the percentage of animals thus affected (and it will not probably be found to be in excess of those figures), I will call your attention to the following extracts from the report of the Veterinary Department of the Privy Council Office for the year 1879:

"The slaughter of large numbers of American swine at the port of landing, on account of swine fever, afforded an opportunity of obtaining specimens of flesh for examination, with a view to ascertain what proportion of the animals were infected with trichinæ. The inspectors of the Veterinary Department examined 279 separate portions of swine's flesh which were sent from Liverpool, and detected living trichinæ in three specimens; * * * but it was not deemed expedient to prohibit the introduction of American pork into this country, for the reason that such a measure would have damaged the trade without producing any satisfactory results. A large proportion of the objectionable meat would have been sent to this country by a circuitous route, and thus the object of the restriction would have been defeated, *besides which, trichinosis among swine* is known to exist in *Germany*, and it probably exists in other exporting countries, so that nothing short of total prohibition of swine flesh in all forms from all foreign sources would have been effectual."

In view of the recent total embargo placed by some of the foreign governments upon the imports of our hog products into their countries, on account of the alleged existence in them of *trichinæ*, I would suggest that an inquiry be established which shall point out, first, the actual percentage of American hogs that are infected by this parasite; second, the portion of the country in which the largest percentage of animals so affected are found to exist; third, the nature of the food, if there is any difference, that these pigs receive; fourth, whether animals that are kept around the home buildings are more subject than are those kept in the field to the invasion of this entozoon, and all other matters relating to the question which may aid in devising such means as shall decrease to a minimum their existence in American pork products.

CONDITION OF ANIMALS ARRIVING IN GREAT BRITAIN.

The losses occasioned by death and injury to cattle while being shipped abroad have been greatly reduced, and they are now landed at the various ports of Great Britain in a much better condition than formerly. Indeed, notwithstanding the much greater distance they are necessarily carried, they arrive with fewer bruises and in better condition generally than do those from some of the neighboring European ports. This gratifying condition of affairs is due to the good care and improved methods of ventilation, &c., adopted by the owners of steamships. Experience in the trade, and the requirements of the insurance companies, have compelled many improvements for the comfort and safe transport of these animals. More light and space are given them, and by means of various ventilating devices an abundance of fresh air is furnished throughout the entire voyage. In most of the vessels a method of drainage into the bilge has been arranged, which may be pumped out as often as desirable. While much has been done in this direction by the steamship owners alone, the managers of the insurance companies interested have not been idle, but so great has been the care exercised by them in the selection of animals for transportation and the provident provisions made for them during the voyage that the losses, which amounted to more than 5 per cent. from January 1 to September 30, 1880, have been reduced to about 2½ per cent. during the same months of this year. Notwithstanding this great improvement, the weather during some parts of the past season has been the most severe ever known to the trade.

Very respectfully,

CHARLES P. LYMAN, *F. R. C. V. S.*

WASHINGTON, D, C., *November* 15, 1881.

CONTAGIOUS PLEURO-PNEUMONIA IN NEW YORK.

REPORT OF DR. HOPKINS.

Owing to circumstances over which the department had no control, the investigation in the State of New York was brought to a close on or about the 20th of May last. The examinations made in that State by James D. Hopkins, D. V. S., from April 8 to May 17, will be found recorded below. From information received from the highest authority in such matters in this State, it would seem that contagious pleuro-pneumonia prevails to about the same extent that it did prior to the recent efforts of the State authorities to stamp it out. Dr. James Law, in writing to the Commissioner of Agriculture, under date of October 10, last, says:

"Putnam County, which was purged from the plague in the early part of last year, has been infected (one herd at least) for the whole past summer; Westchester County contains at least two centers of infection, and Richmond (Staten Island) two, though both these counties had been purged of the infection; New York City, which was all but rid of the plague, harboring it only in places known and circumscribed, is again suffering; and finally, the east end of Queen's County, which had been long clear, has been extensively infected."

[For detailed report of examinations made by Dr. Hopkins see next page.]

Number and location of diseased herds examined by Dr. Jas. D. Hopkins.

Name of surgeon.	Name of owner.	State.	County.	Day examined.	Number in herd.	Number sick.	Number died.	Name of disease.
				1881.				
Jas. D. Hopkins, D. V. S.	Michael Tierney	New York City, 23d Ward	New York	Apr. 8	17 head (a)	Not given	6	Contagious pleuro-pneumonia.
Do.		New York City	do	Apr. 8	24 cows (b)	do	(Killed.)	Do.
Do.	David Titus	do	Queens	Apr. 22	13 cows (c)	do	5	Do.
Do.	Ann N. Titus	do	do	Apr. 22	21 head (d)	do	7	Do.
Do.	Valentine Willets	do	do	Apr. 22	14 cows (e)	do	5	Do.
Do.	C. C. Willets	do	do	Apr. 22	13 cows (f)	1	1	Do.
Do.	Fred. Willets	do	do	Apr. 22	9 cows and 6 calves (g).	Not given	1	Do.
Do.	Jas. A. Hayt	do	Putnam	Apr. 27	Not given (h)	7 head	6	Do.
Do.	D. P. Titus	do	Queens	Apr. 28	7 head (i)	8 head	2	Do.
Do.	Richard C. Hubbs	do	do	Apr. 28	12 head (j)	Not given	11	Do.
Do.	M. R. Hines	do	do	Apr. 28	10 head (k)	1 acute and 6 chronic cases	2	Do.
Do.	Philip Seibert	New York City, Blissville.	do	May 12	22 head (l)	2 acute cases		Do.
Do.	J. S. Daugherty	do	do	May 12	16 head (m)	1 chronic case		Do.
Do.	Joseph Stevenson	do	do	May 12	30 head (n)	3 chronic cases		Do.
Do.	W. H. Cutter	New York City, Port Richmond.	Richmond	May 17	24 head (o)	1 chronic case	10	Do.

(a) These animals died between October, 1880, and March 1, 1881.
(b) These cows were bought at the Central Stock Yards; and conveyed by regular cattle boat to Eisness' slaughter house, Forty-fourth street.
(c) These cows died since January 2, 1881; the last one died February 24.
(d) There are seven chronic cases. This herd was inoculated by cattle on adjoining farm of R. H. Robbins, who had lost 7 or 8 cows out of a herd of 20.
(e) Inoculated by cow bought from dealer in October last.
(f) Killed diseased cow and inoculated remainder in October, and has had no disease since.
(g) He sent three cows to the butcher and inoculated the remainder. Inoculation seems to give satisfaction to the people in this locality.
(h) Has lost six valuable animals up to date, and has seven still suffering with the disease. His place has been quarantined.
(i) These animals died last winter, and he now has three chronic cases.
(j) These animals died last fall. No sick animals at present.
(k) These two cows were lost about a month ago; thinks his animals were infected by Hubbs' cattle. His place has been quarantined.
(l) Swill stables.
(m) Swill stables.
(n) Swill stables.
(o) The disease appeared here about the 1st of March last, since which time ten animals have died.

CONTAGIOUS PLEURO-PNEUMONIA IN NEW JERSEY.

REPORTS OF DRS. MILLER AND CORLIES.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: In accordance with your request I have the honor herewith to forward you a brief summary report of the work done upon the veterinary staff of the Department of Agriculture since the date of my appointment, May 12 last, until the present time.

My first official act, after receipt of proper authority, was to establish a border quarantine between Philadelphia and Camden, and other points on this side of the river, in order that cattle passing over the ferries should be detained for the purpose of inspection.

To facilitate the transportation and examination of the same, cattle pounds were erected at each ferry yard into which all stock were ordered to be driven and detained until such time as they could be seen and inspected.

Owing to the distance of some of the ferries from a central locality, much delay must sometimes be necessarily imposed, and I very soon found it absolutely imperative to employ a proper person to watch and assist at the yards in order to prevent some of the drivers from removing their stock prior to examination. The person so employed was invested with authority to arrest any person or persons unwilling to comply with the order of quarantine and inspection. I am happy to state that no arrests have thus far been required, as I have endeavored to accommodate all parties as far as was in my power as rapidly as possible, and in order to do so have very frequently had to employ the assistance of Dr. Zuill, D. V. S., of Philadelphia, to visit a number of the ferry yards while I was engaged at others.

Since the establishment of the quarantine order, 7,164 cattle have been examined. Many of them have been sick with the ordinary diseases of cattle, and quite a number have been found to be infected with diseases of an infectious or contagious character. But I am glad to inform you that but very few cases of contagious pleuro-pneumonia (the disease for which I was instructed to examine) have been found in comparison to the number of cattle examined. All of them, however, have been carefully reported to the department, and the source of the disease traced whenever it was possible to do so.

The first case was discovered June 29, 1881, and the animal traced back to Wilmington, Del., where she was reported as one of a lot that came from Baltimore, Md. Another case, on July 6, in a lot of four calves from Marple, Delaware County, Pennsylvania, all of which were slaughtered at the abattoir, and two of which showed lung lesions. The next case, on July 12, that of a cow and calf in a lot of eighteen from West Philadelphia stock yards. The cow was ordered to be killed by the State board of health, and a *post-mortem* examination revealed the disease well marked in both lungs; lesions were also plainly seen in the lungs of the calf. On July 22 a calf brought from Guineatown, Bucks County, Pennsylvania, was detected by Dr. Zuill, and the case referred to me, which I immediately condemned to be slaughtered, when a *post-mortem* examination fully confirmed our diagnosis.

On the 14th of September two cases were ordered into close quarantine as very suspicious. A proper history was afterward obtained, stating that they originally came from West Virginia to Baltimore, where they were resold and shipped from Baltimore stock yards to West Philadelphia. Being fat, they were ordered to the abattoir for slaughter, and a *post mortem* examination showed the suspicions to be well founded.

On the 22d of September two cows were discovered in a herd that came from Glendale, Northampton County, Pennsylvania. On the 29th two others, in a lot that came from Bethlehem, Pa., all of which had been herded together at the New Jersey State Fair, in charge of A. S. Shimer, and which were affected with lung trouble. A subsequent investigation made by Dr. Gadsden, of Philadelphia, would seem to indicate that the animals had no contagious disease. He did not, however, see the cattle at the time of his visitation, but did see others of the same herd. Almost daily cattle affected with *Phthisis Pulmonalis Verminalis* (hoose or husk) are seen at the ferry yards, and in view of the fact that this affection has been alarmingly fatal in young animals in this State during the last two or three years, it would seem as if some legal measures should be adopted to prevent its spread. Other diseases of animals, such as swine plague, glanders in horses, chicken cholera, foot-rot in sheep, etc., are existing throughout the whole State, and call for some action on the part of government.

During the time that has elapsed since the date of my appointment, especially during the latter part of July and the month of August, I made weekly visits to the State of Delaware as instructed, and found many cases of infected farms and several acute and chronic cases of pleuro-pneumonia. That part of the State immediately bordering upon Pennsylvania and the eastern shore of Maryland is certainly an infected locality, and the section surrounding Wilmington had suffered from the ravages of the disease. The law in that State is inoperative, and no measures are taken to prevent the spread of disease.

From my investigations thus far, I must conclude that contagious pleuro-pneumonia of cattle exists in New York, New Jersey, Pennsylvania, Delaware, and Maryland; that other diseases of animals, especially swine plague, glanders, and chicken cholera, are to be found in every section of the country. From my personal experience, of the last two years particularly, I believe that the only way to exterminate these diseases is to stop the interstate traffic in animals from infected States, to thoroughly examine all cattle crossing from one State to another, whether from infected States or not, and to destroy all diseased and exposed animals at sight.

Since the system of inspection was adopted at this point a very decided change has taken place in the general appearance of the animals crossing these ferries. Instead of poor, delicate looking, half-starved animals, or sick or almost disabled, as was formerly the case, none now appear for inspection but the very best, and it certainly has proven a source of great benefit to this section particularly. No suspicious or unhealthy cattle are allowed to pass when they do appear. As a result, dealers and drovers do not attempt to pass inferior animals over if they can possibly avoid it. Occasionally, however, a stranger will come with a lot driven directly from the country, or some parties will go to the stock yards and purchase a poor class of animals simply because they can buy them cheap, and I invariably subject them to a thorough examination and inspection.

The work has been vigorously and thoroughly accomplished, and great good has been derived therefrom.

Respectfully submitted.

WM. B. E. MILLER, *D. V. S.*

CAMDEN, N. J., *October* 31, 1881.

HON. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: I have the honor to submit the following report of the work done by me since acting as agent for the Department of Agriculture in investigating, inspecting, locating, and reporting the existence of contagious pleuro-pneumonia among cattle in this State. On March 21, 1881, I received my appointment and letter of instructions, and immediately proceeded to visit localities that were known to have been infected by the malady in the past. My previous connection with an organization that existed in this State a year prior to this time, made me somewhat familiar with such places. I also prepared and had printed two thousand circulars which I caused to be circulated among stock raisers in different parts of the State, requesting those having the malady, or reasons to believe they had it in their herds, to report the same to me at my office without unnecessary delay, and I am happy to state a number responded to it. Upon investigation, however, a majority of cases proved to be some other form of disease resembling contagious pleuro-pneumonia in its symptoms. I, however, found, as a rule, the farmers were difficult to approach, and in a number of cases tried to cover up the existence of the disease as much as possible. This difficulty may be overcome by arming those whose duty it is to make inspections, with authority to enter any premises where they suspect the malady to exist. Being at liberty to exercise my own judgment in adopting the best means to find where the disease existed, I consulted the State board of health through its secretary, and made a proposition to go personally to all reported infected places, make the necessary inspections, and furnish a duplicate report to them free of expense, if they would acquaint me with cases reported to them.

The movement of cattle out of the State is limited to high-bred stock, and from farms that are so well managed that contagious diseases cannot get a foothold. There are, however, a large number of young calves moved from New York for slaughter, through the abattoir building, at Jersey City, to various parts of the State, and as there are no restrictions imposed they may be a means of conveying pleuro-pneumonia to other localities. The most of the calves raised in the State are fattened and disposed of to the butchers.

The annexed tabulated report cannot be relied upon as showing the actual extent of contagious pleuro-pneumonia in the State at the present time. Enough, however, has been gained to show that it has an actual existence, but not to the same extent as it did at the time of the going into effect of the first act, approved March 13, 1879.

Number and condition of herds examined.

Counties.	Herds.	Number.	Sick.
Atlantic	2	40	....
Burlington	5	76	....
Camden	....	....	....
Cumberland	....	....	....
Bergen	3	29	5
Essex	10	139	15
Gloucester	3	54	....
Hudson	10	120	12
Hunterdon	2	76	....
Middlesex	15	132	8
Mercer	5	73	5
Monmouth	9	131	....
Morris	6	85	2
Passaic	3	33	2
Sussex	2	92	....
Somerset	3	36	1
Ocean	9	141	....
Union	6	132	2
Warren	4	60	....
Cape May	....	....	....
Total	97	1,449	52

Respectfully submitted.

JAMES C. CORLIES, *D. V. S.*

NEWARK, N. J., *October* 11, 1881.

CONTAGIOUS PLEURO-PNEUMONIA IN PENNSYLVANIA.

REPORT OF DR. GADSDEN.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: In accordance with instructions from your department, I herewith submit a statement of the extent to which "contagious pleuro-pneumonia" has prevailed recently in this State, and the efforts made by the State authorities for its extirpation.

The disease has existed in the State of Pennsylvania, to a greater or less extent, for a number of years; and although the legislature, by act of April 12, 1866, endeavored to prevent its extension and prescribed penalties for those disposing of or removing infected animals, no systematic attempt seems to have been made looking to the eradication of the disease by the destruction of affected animals, until the spring of 1879, when, alarmed by the fact that the ports of Great Britain had been closed to cattle shipped from the United States, and it being learned that in several counties of the State the disease at that time existed, a bill was introduced in the legislature providing for the stamping out of the contagion. This measure met with most vigorous opposition, caused, mainly, by the declaration of certain veterinary surgeons, that the disease was not contagious. By the earnest efforts, however, of Mr. Thomas J. Edge, secretary of the State board of agriculture, who was in possession of the testimony of dairymen and farmers who had suffered from the ravages of the disease, and of veterinary surgeons who had had actual experience with it both in this country and in England, and consequently were well aware of its contagious character, the act of May 1, 1879, passed both branches of the legislature, and was approved by the governor.

Immediately after its approval the governor appointed a commission to "examine and determine whether infectious or contagious pleuro-pneumonia existed among cattle in any county or counties of this commonwealth, and report the same without unnecessary delay." After hearing the testimony of a number of practical dairymen and veterinary surgeons, the commission decided unanimously and reported to the governor that the disease did exist in at least two counties in the State.

Upon the receipt of this report, the governor appointed Mr. Thomas J. Edge his special agent and assistant, to carry out the provisions of the acts of 1866 and 1879, for the prevention of the spread of this disease, and issued to him a commission and instructions for his government.

Too much praise cannot be given to this gentleman for the energetic manner in which he has fulfilled the duties of his appointment, and the great results he has accomplished at a comparatively trifling expense. He immediately appointed, in the several counties of the State, 450 persons as official reporters, with instructions to communicate to him at once the existence of any infected animals, or those supposed to be infected; and upon receipt of such information a veterinary surgeon was at once sent to examine the animals, and if the disease was found to be that of contagious pleuro-pneumonia, the entire farm was placed in quarantine, the animals appraised, those diseased killed and paid for by the State, and the others kept under surveillance until three months after the last trace of disease was discovered, when the quarantine was removed.

From May 1, 1879, to the present time, 64 herds, numbering 1,252 animals, have been placed in quarantine, 324 animals have been killed, of which 257 were paid for by the State, the entire cost to the State being only $10,750, of which $4,325 was paid for animals destroyed.

The disease has been confined to nine counties in the eastern and southern sections of the State, the herds quarantined being distributed among the counties as follows:

Adams	1	Montgomery	17
York	2	Bucks	3
Lancaster	2	Lehigh	1
Chester	15		
Delaware	17	Total	64
Philadelphia	6		

In many of these herds the cause of infection has been traced directly to diseased animals brought from Maryland and placed among healthy cattle, numbers of which were infected by them. In other instances the disease was communicated from chronic cases that had apparently recovered; in others, by the contact of persons who had been attending diseased animals and afterwards went among healthy ones without first disinfecting their clothing. In still other instances it was communicated from one farm to another by means of streams of running water, or by healthy animals being allowed to graze in fields adjoining those in which diseased ones were pastured.

At the present time the disease is confined to the counties of Delaware, Montgomery, and Philadelphia; in the former of which three herds numbering 36 animals, in Montgomery one herd numbering 19 animals, and in the latter one herd numbering 41 animals, are now in quarantine.

The disease at present in Delaware County was introduced to one herd by cattle from Baltimore, Md., and communicated from this herd to two adjoining farms. The existence of the disease was discovered by Dr. Bridge, the State inspector, by the meat of diseased animals being exposed for sale in the Philadelphia markets.

There is no question that the State of Pennsylvania would be entirely free from infection to-day were it not for the fact that no precautions are taken by the Maryland authorities to prevent the spread of the contagion; diseased animals from that State are constantly brought into this and thus infect healthy herds.

Since my appointment by the Department of Agriculture, I have been in constant communication with the State authorities and they have always co-operated with me in all measures for the discovery of the disease and have labored faithfully to prevent its spread.

The calves in all infected districts are slaughtered by direction of the State inspector, and are not allowed to be removed into other portions, or out of the State, for fear of spreading the infection.

By official statistics the number and value of cattle in Pennsylvania, last year, was:

Cows	851,790	$18,625,000
Oxen and other cattle	674,000	14,962,000
	1,525,790	33,587,000

When the amount of money invested in cattle is considered, the sum expended by the State for stamping out the disease seems very insignificant; yet the State officers were very much crippled in their operations by a decision of the auditor-general, made in June, 1881, that the payment for cattle destroyed was not a necessary expense within the meaning of the act, and refusing to allow any claims for such payment; and it was not until October 15, 1881, that he was induced to reconsider his decision and allow such claims, and only then provided the total amount expended for the year should not exceed $5,000.

In the mean time some diseased animals had been introduced from Baltimore, and we have learned of instances where the owners of them concealed the fact, knowing that the State had ceased payment.

In conclusion, from personal observation and the reports received from those actively engaged in its suppression, I am convinced that the disease can never be effectually eradicated without—

First. A more efficient quarantine;

Secondly. The killing of all chronic cases, no matter how *apparently* healthy the animals may be; and,

Thirdly. The adoption of stringent regulations for the proper inspection of all animals removed from one State to another, the inspector to have full power to cause the instant destruction of all diseased animals.

The present system of quarantine seems to be almost a farce. The animals are allowed to roam at will over a whole farm, and are placed in fields bordering on public roads, and divided from neighboring farms only by an open fence. In this way the disease has been communicated in a number of instances. The only effective way would be to confine all animals that have been subjected to infection in an inclosure remote from other cattle, separating the sick animals from the healthy ones, and allowing no one who has had access to the diseased animals to approach the healthy without first thoroughly disinfecting their clothing.

Chronic cases, although the animals may be apparently healthy, are but moving centers of contagion, for from the nature of the disease the lungs once affected never resume their normal state, and we have several instances where these chronic cases have affected herds, and the animal communicating the disease has outlived those infected by it.

From the experience of this State, the necessity of preventing the transmission of the disease from one State to another cannot be overestimated, and until a law looking to this end is enacted, it will be impossible to rid the country of the disease, for, one State refusing action, may endanger all those lying contiguous to it, even though they may be using every endeavor to rid themselves of the plague.

Respectfully submitted.

JOHN W. GADSDEN, M. R. C. V. S.

PHILADELPHIA, *October* 31, 1881.

Number and location of diseased herds examined by Dr. J. W. Gadsden.

Name of surgeon.	Name of owner.	State.	County.	Day examined.	Number in herd.	Number sick.	Number died.	Name of disease.
				1881.				
J. W. Gadsden, M. R. C. V. S.	Jacob K. Ulrich	Pennsylvania	Delaware	Mar. 31	(a) 24	Not given.	3 killed	Contagious pleuro-pneumonia.
Do	Ed. Krider	do	Philadelphia	Mar. 31	(b) 31	do	15 killed	Do.
Do	James Milner	do	Bucks	Mar. 31	(c) 8	do	4 killed	Do.
Do	Jacob K. Ulrich	do	Delaware	Apr. 7	(d) 21	do		Do.
Do	Ed. Krider	do	Philadelphia	Apr. 7	(e) 16	do		Do.
Do	James Milner	do	Bucks	Apr. 7	(f) 4	do		Do.
Do	David P. Forney	do	York	June 2	(g) 11	1		Do.
Do	do	do	do	June 23	(h) 11	3		Do.
Do	M. Worral	do	Delaware	June 23	(i) 31	4		Do.
Do	do	do	do	June 30	(j) 30	12	1	Do.
Do	do	do	do	July 14	(k) 29	11	1	Do.
Do	Alonzo Parker	do	do	Aug. 25	(l) 12	2	2 cows killed.	Do.
Do	do	do	do	Sept. 8	(m) 11	1	1 killed	Do.
Do	do	do	do	Sept. 15	(n) 10	4	1 killed	Do.
Do	M. Worral	do	do	Sept. 15	(o) 24	Not given.		Do.
Do	Nicholas Bowden	do	do	Sept. 15	(p) 15	2		Do.
Do	Alonzo Parker	do	do	Sept. 22	(q) 9	3	1 killed	Do.
Do	M. Worral	do	do	Sept. 22	(r) 21	Several.		Do.
Do	Nicholas Bowden	do	do	Sept. 22	(s) 15	1		Do.
Do	John H. Webster	Philadelphia, Pa.	Philadelphia	Oct. 20	(t) 42	5	2	Do.
Do	John S. Andrews	Pennsylvania	Montgomery	Oct. 9	(u) 19	2	2 killed	Do.

(a) Twenty-one animals have been quarantined by order of State authorities. (b) Sixteen animals in quarantine by order of State authorities. (c) Remaining animals in quarantine. (d, e, f) Four animals belonging to Mr. Ulrich's herd were, a few days after this report was made, slaughtered for beef and showed no evidences of disease. During the month Mr. Milner's herd, having developed no symptoms of disease, were ordered from quarantine. No evidences of disease having appeared in the herds of Messrs. Ulrich and Krider, they were also released from quarantine early in June. (g) This animal was infected by a cow purchased in Baltimore, which was suffering with chronic contagious pleuro-pneumonia; quarantined. (h) Herd still in quarantine. (i) Infected by stock from Baltimore. Quarantined by order of State authorities. (j, k) At the foregoing date this herd is represented as being in a sad plight; one animal died July 12, another August 4, and still another August 17. The herd was properly quarantined. (l) The two cows killed on August 23 were in the last stages of the disease; animals were infected by Worral's herd on adjoining farm; quarantined. (m) This animal was killed by order of State authorities. (n) A second animal was killed by order of State authorities on September 14. (o) The State inspector regards 15 of these animals as chronic cases. (p) Infected by adjoining herd belonging to Mr. Worral; quarantined. (q) This animal was killed by State inspector. (r) The animals sick are chronic cases and are doing well. (s) No changes since last report. (t) These animals died but recently. The owner was of the opinion that the State had ceased to pay for condemned cattle, and hence made no report. (u) On November 8, when again examined, two more animals in this herd were found sick. The herd is still quarantined.

CONTAGIOUS PLEURO-PNEUMONIA IN MARYLAND, THE DISTRICT OF COLUMBIA, AND VIRGINIA.

Report of Dr. Rose.

Hon. George B. Loring,
Commissioner of Agriculture:

Sir: By request I forward you a report of my investigations throughout the State of Maryland and the District of Columbia, as inspector of contagious pleuro-pneumonia in cattle. It will be necessary to subdivide my report, in order to impress upon the minds of those who may read it the fact of the existence of such a terrible malady; also to what extent it has been transmitted, and the amount of virulence contained in each infected stable and district. It is my intention to give you a report of the past as well as of the present, and for this purpose I have kept a complete record of those who have lost stock during the existence of this disease. I am satisfied, however, that I have missed many stables where the disease previously existed, which fact I attribute to the fear of owners of neat cattle who have experienced the ill effects of the disease among their stock. One point to be remembered is the non-existence of this disease on some farms where it was reported by the owners to have previously prevailed. It is true that some people have confounded this disease with the southern cattle fever, which may be very readily distinguished by the general observer during the existence of either of these diseases; but in making a diagnosis of a certain disease of the past, with an imperfect history to guide us, we are compelled to reserve our decision. This I found to be the case about Alexandria, Va., and in some parts of Maryland. The majority of intelligent people who read the symptoms, course, and termination of contagious pleuro-pneumonia in cattle, generally quote the remarks given by our standard authors of the very malignant form of the disease. It appears deeply impressed upon their minds that all cases must show these severe symptoms. It would be well if such was the case; more of them would die. This would lessen the spread of so contagious and infectious a malady. But all cases do not die (unfortunately); convalescents transmit the disease to other animals, especially if removed from the infected stable to a healthy herd of cattle in some other locality. Again, some animals do not show any symptoms of the disease, although others about them may die. I wish to impress upon the minds of cattle-owners the necessity of watching these cases with care; oftentimes they are the means of transmitting the very worst form of the disease to other animals. They are often affected but slightly, resolution having taken place before any external symptoms are observable. Although these remarks are well understood by yourself, still I think them very necessary for the benefit of cattle-owners, especially in Maryland.

INFECTED LOCALITIES IN BALTIMORE CITY AND COUNTY.

I commenced my investigations as inspector of cattle in the State of Maryland for the Department of Agriculture, March 28, 1881. In beginning my report of this city and county, and before alluding to the ravages of the malady in the past, it will be necessary to mention the stables in which the disease existed at the time of my investigations. April 7, 1881, I found an infected stable four miles north of Baltimore city, belonging to Judge D. M. Perine. He owned at this time some valuable stock. I found several of them sick with contagious pleuro-pneumonia. No history relating to its origin among his cattle could be obtained until the hired man spoke of a bull which belonged to a neighbor named J. B. Manning. This bull was allowed to enter the barnyard of Judge Perine at all times. Being suspicious of this animal, I made inquiry regarding his whereabouts during the past six months. I found, by further inquiry and careful examination of other herds in this locality, that he had infected animals belonging to Mr. Thos. R. Jenkins and Mr. J. W. Ward. The former had six cows, one of which I examined and found the left lung consolidated in its middle and upper portions; hydrothorax was present; temperature 104$\frac{3}{5}$° F.; died April 10. Precautions were taken to prevent its spread if possible. Mr. Ward, who owned four cows, was less fortunate. He wintered the animals belonging to Manning. I found one of this herd sick with the disease. Temperature 104° F.; slight dullness on percussion over the right lung, with the characteristic cough. This cow died one month later, but previous to her death another one of the four was attacked. Owing to the lack of power to destroy these infected animals, I was compelled to allow them to roam about the farms, to further disseminate the disease. Manning's place has been infected for the last ten years. He has lost cows at different periods, sometimes one, at other times two or three animals, and has thus kept up a constant supply of virus sufficient to infect animals entering his stables at any season of the year, or that might come in contact with his recovered cases.

About the middle of April last I visited a section of Baltimore county called Long Green and Delaney Valley, distance seventeen miles northeast of Baltimore city. Most of these farmers have valuable stock in the line of milch-cows. Thos. Pierce claims to have had the first outbreak of the disease in his section of Baltimore county this spring. His farm consists of 1,000 acres of land, most of which has been used of late as a pasture field. Cattle come here from all parts of this county to graze. He could not tell me how his cattle contracted the disease. I found a herd consisting of 30 cows and 2 bulls. Four of the cows were sick with the disease, and 5 others had died previous to my visit. His neighbor, who owns the adjoining farm, lost 9 cows with the same malady, while others were suffering with it during my visit. I was not satisfied with the history given me by the hired man on the latter place, which is owned by General Trimble, but the General admitted that one of his animals jumped the fence into the pasture field belonging to Mr. Pierce. Three weeks after he noticed this outbreak among his cows. I went from this place to Long Green, which is 2 miles east of Delaney Valley, to examine a herd of cattle, consisting of 10 cows and 1 bull, belonging to John A. Conklin. Mr. Conklin allowed 2 of his cows to winter on the Pierce farm. Hearing of this outbreak, he had his cows returned to his own farm, but, shortly after, the disease appeared in his herd. Five animals were attacked at different periods, and, during the months of March and April, 2 died. No disinfectants were used, and great negligence was manifested, and I was not surprised to find on a second visit toward the close of April that other animals were affected. In the barn one case was found. Calling again, about the same time, at Mr. Conklin's place, I found no change in his animals, except that, in the interim, he seems to have used disinfectants freely. Two sick animals were allowed to roam at will over his entire farm.

On May 4th and 5th I visited a place called Glencoe (Northern Central Railroad), situated on the Baltimore and Yorktown turnpike. Here I found four gentlemen, owning adjoining farms, who had experienced heavy losses in cattle. Dickinson Gorsuch, who lives one mile west of Glencoe, had the first outbreak of contagious pleuro-pneumonia in this neighborhood. Many head of cattle have died with the disease on his place since 1876. It was transmitted from this farm to that of T. T. Gorsuch, a relative, who lives one-half mile east. On the same turnpike, opposite the former place, lives another relative, Joshua Gorsuch, whose cattle also contracted the contagion. The latter sold a cow affected with the disease to a man named Jessup, who lives in this locality, which soon infected his stock, ultimately causing a heavy loss. I recite this history simply in order to explain the transmission of the disease from one place to another. I found two chronic cases on the farm of T. T. Gorsuch. Adjoining lives another relative named Alfred Mays, on whose place I found 3 cows, out of 5, sick with the disease. A cow had died previous to my visit. I advised the owner not to permit his cows to go to other pastures. He paid no attention to my advice, but allowed the sick animals to leave his place to graze on his father's farm, distant 1½ miles north. I followed the animals to his father's (Jno. P. Mays), where I found the disease prevailing among his cattle. He has lost 12 head of fine Ayrshires and Alderney cows during the past six weeks. I saw 4 others suffering with the disease. The first animal to infect this locality was brought from Baltimore city.

On March 30 I visited a dairy stable near Cathedral street, Baltimore, belonging to Jno. McCormack. I found a case of contagious pleuro-pneumonia among this herd of seven cows; recovered, but right lung affected. On May 16 another cow in this stable showed symptoms of the disease.

On April 1 the stable of Herman Breakman, Highlandtown, contained 5 cows, one of which was suffering with the disease.

About the same time I visited the stables of Mr. Douglas, Upper Canton, 1½ miles east of Baltimore. This stable contained 52 cows, all of which had been inoculated with the virus of contagious pleuro-pneumonia. I have made repeated visits to this place for the purpose of studying the effects of inoculation. But owing to the continual exchange of cattle, I have gained but little information. I could detect no cases, although the disease existed here last summer.

On April 12 I visited the dairy farm belonging to Chas. P. Harrison, of Pikesville. This and the Douglas farm are the only farms on which inoculation has been practiced in the State, to my knowledge. Mr. Harrison says he has been exempt from the disease since 1873, and claims inoculation as a great preventive measure.

On April 2 I visited the dairy of Mr. Jeokel, one mile east of Baltimore. This herd consisted of 50 cows. In his stable I found 5 recovered cases. This gentleman lost a great many cattle last summer by the disease; but could not, or would not, tell how many.

On April 5 I visited South Baltimore. I found this section of the city also infected. Wm. Hamburger (dairyman), Hanover street, had 18 cows, among which was one chronic case of contagious pleuro-pneumonia. This place has been infected for at least six years. There are other dairies in close proximity to this one. If one of them remains free of the disease for a short period the others will have one or more cases to contend with. I have made many visits in this section of the city, and I have invariably detected at least one case of the acute type of the disease. Recently I explained to Dr. Lyman the condition of this locality, and on visiting it pointed out to him two acute and one chronic case of the disease. I found also one dead animal on the commons near these stables. We had the dead cow removed to the bone-yard, and the post-mortem examination revealed all the charateristic lesions of the disease. I may safely say that the diseased lung weighed at least 35 pounds. The diseased animals on the commons were allowed to commingle with the healthy ones. This man has lost, by contagious pleuro-pneumonia at least 35 head of cows within the past six years. In all such infected localities I find the people attribute all this trouble to dealers in cattle. A majority of fresh cows purchased of these dealers are healthy at the time they enter these infected stables, and they develop the disease sooner or later afterwards. Edward Sachs and brothers keep separate dairies, but occupy the same stable, which is separated only by a partition wall in its center. They usually have 30 or more head of cows, among which I have occasionally found a diseased one.

Cornelius Frostler (dairyman, same locality) owns 13 cows, and tries to keep that number on hand. I found 3 chronic cases of contagious pleuro-pneumonia in this stable on April 5. I have made several visits here each month, but have failed to detect an acute case. Animals are not often exchanged in this stable, which has a tendency to lessen the number of acute cases. On June 10 one of his cows died with the malady.

John Hillar (dairyman, same locality). This stable contains 13 cows and has been infected for a long time. On June 8, after lingering some time with the disease, one cow died. On June 10 I found two others suffering with the disease. On June 23 one of the sick animals, which I found on the 10th instant, was missing. The other one was still lingering. On July 27 I found two more of these cows sick with contagious pleuro-pneumonia; four others had been removed from the stable and new cows placed in their stalls.

On April 7 I visited a dairy belonging to David Stevens, at Woodberry. Here I found 7 recovered cases, from the outbreak which he experienced last year. He lost at least 20 head of cows at that time from the effects of the disease. One cow died the day previous to this visit. The lungs were shown to me. The right lung was completely consolidated throughout its anterior lobe. Since then I have been unable to detect any more affected animals in this stable. Mr. Stevens has decided to part with every cow which shows the slightest symptoms of the disease.

Infected localities in Baltimore City and County prior to 1881.

Name of owner.	Localities of infected stables and premises.	No. died.	Year.
Laurence Weimbeck	Highlandtown, one-half mile east of Baltimore, Baltimore County.	6	1880.
Mr. Michaelman	do	4	1880.
Mr. Kiefer	do	8	1880.
Mr. Doran	do	Unknown.	1880.
Mr. Douglas	One and a half miles east of Baltimore, Baltimore County.	Unknown.	1880.
R. Brooks	Canton, east of Baltimore, Baltimore County	20	1880.
John Sweeny	East of Baltimore, Baltimore County	3	1880.
John Baumgartner	Northeast of Baltimore, Baltimore County	Unknown.	Unknown.
Patrick Holland	Philadelphia Road, east of Baltimore, Baltimore County.	35	1871.
Mrs. Hartman	do	Unknown.	Unknown.
George Furley	Canton, east of Baltimore, Baltimore County	Unknown.	Unknown.
Mr. Zorn	do	Unknown.	Unknown.
Mrs. Clay	do	8	1880.
B. Miller	Patapsco Neck, two and a half miles east of Baltimore, Baltimore County.	Heavily.	1880.
Henry Hughs	North end of Baltimore, Baltimore County	3	1879.
Mr. Lenne:	do	5	1879.
James M. Davis	Huntington avenue, north end of Baltimore, Baltimore County.	Unknown.	1871.
A. S. Abell	Four miles north of Baltimore, Baltimore County.	1	1880.
J. R. Manning	Three and a half miles north of Baltimore, Baltimore County.	22	Since 1861.
William Hamburger	South of Baltimore, Baltimore County	35	Since 1875.
George and Edward Sachs	do	(*)	
Mrs. Sweigert	do	2	1880.
Cornelius Frostler	do	4	Since 1878.
John Hillar	do	Unknown.	
George Klein	do	Unknown.	
John Rugall	Washington Road, near Baltimore, Baltimore County.	17	Since 1871.
John Bair	do	Unknown.	

Infected localities in Baltimore City and County, &c.—Continued.

Name of owner.	Localities of infected stables and premises.	No. died.	Year.
Mr. Rogan	Washington Road, near Baltimore, Baltimore County.	Unknown.	
Mr. Fogal	do	60	Since 1870.
Mrs. Kinny	do	4	1880.
Tho. Langhor	Frederick Road, west of Baltimore, Baltimore County.	37	1872.
John Glenn	Catonsville, six miles west of Baltimore, Baltimore County.	4	1878.
Aug. Lurman	do	6	1874.
Nicholas Boary	Sterrett street, Baltimore, Baltimore County	15	1880.
Ross Winans	Baltimore street, Baltimore, Baltimore County.	Unknown.	1864.
Hayfield Merryman	do	Unknown.	1864.
Mr. Shipley	do	35	1866.
Mr. Ridgely	Towsontown, seven miles north of Baltimore, Baltimore County.	1	1880.
Dr. Piper	do	1	1880.
John Smith	Two miles northeast of Towsontown, Baltimore County,	20	1880.
Jacob Wisner	One mile east of Towsontown, Baltimore, County.	8	1880.
Samuel E. Parks	do	10	1879.
William Williams	Govanstown, four miles north of Baltimore, Baltimore County.	5	1876.
P. McGreever	do	5	1879.
William Anderson	Hillen Road, near Govanstown, Baltimore County.	20	1880.
Charles P. Harrison	Pikesville, six miles northwest of Baltimore, Baltimore County.	Heavily.	1878.
Dr. B. E. Wood	Hillen Road, near Govanston, Baltimore, County.	6	1880.
John W. Wagner	Pikesville, six miles northwest of Baltimore, Baltimore County.	1	1880.
Slade & Scribner	One and a quarter miles from Pikesville depot, Baltimore County.	10 *	1879.
C. L. Rogers	One mile from Pikesville depot, Baltimore County.	12	1876.
James Lyon	do	Unknown.	
McDonough Institute	Near Pikesville depot, Baltimore County	6	1880.
—— McCauley	do	Unknown.	
James Vaughan	Mount Washington, Baltimore County	(†)	
Charles Baker	do	Unknown.	
David Stevens	Woodberry, Baltimore County	20	1880.
Denis Mathews	Dulaney's Valley, Baltimore County	3	1880.
William P. Hagan	Two miles east of Long Green, Baltimore County.	5	1879.
D. Gorsuch	One mile west of Glencoe, Baltimore County		1876. ‡
T. T. Gorsuch	do	8	1879.
Eli Mathews	One mile west of Monkton, Northern Central Railroad, Baltimore County.	8	1879.
Mr. Russell	Mount Winans, Baltimore County	1	1880.

* Not willing to tell their loss.
† Impossible to tell, constantly changing.
‡ Infected since 1876.

REMARKS.

I cannot give you accurately the aggregate loss sustained by the owners of dairy cows in this city and its suburbs, on account of so many having retired from the business. Many cases of contagious pleuro-pneumonia are hidden from me, not only by the owners of such animals, but many dealers about here make a practice of exchanging such animals. I have repeatedly visited stables in the eastern and southern part of Baltimore, fully expecting to find some acute cases. Occasionally I have succeeded, but not to that extent which I should have done. Some cases which are mild in character are allowed to remain in these stables, providing they assume convalescence. I must confess that these people are very shrewd in their prognosis of such cases. All those that assume the colliquative type of the disease are disposed of prior to death. No later than last year the malady existed in the eastern part of the city to an alarming extent. Very few of the dairy stables escaped its ravages. I have found it a universal fact, not only in this but in other States, that periodical outbreaks of the disease are to be looked for wherever its destructive elements have become imprisoned. In south Baltimore I have noticed isolated cases among the different dairy stables ever since March last. Too much buying and selling is done in both of these sections to ever rid the stables of the disease. They allow a cow to remain in them long enough to develop the malady and then she is hurried off by the dealers to other quarters. This practice is the cause of the transmission of the disease into the outlying counties of Maryland as well as into the States of Pennsylvania and New Jersey. I am convinced that many people have experienced serious losses among their stock from such sources of infection, and yet they seem indisposed to acknowledge the fact. This accounts in a great measure for the many infected farms throughout the interior of Maryland. We have still another source of transmission, that is from those animals called recovered cases. Their tissues are stamped with the virus for an indefinite period of time after convalescence, and where such animals are allowed to exist the virulency of the disease is only reserved for the infection of healthy animals. Many stock-owners in this State have confirmed opinions as to the poor quality of food given and regard this as the cause of disease. This is an absurdity. No matter how an animal may be fed, it must come in contact with a diseased one or enter some infected stable before the contagion can generate in its system. To illustrate this fact we can have no better example than the history of this disease as shown throughout this county.

During my investigations I have been very careful in trying to trace the malady to its origin, but as yet I am unable to find any stable where it existed prior to 1864. At that time most of the cows were sent from the Middle States into Baltimore and Washington, the war having stopped the supply. At this time the disease was known to but few people. Ross Winans, of Baltimore, who was among the first to experience the disease, tried his utmost to prevent the public from knowing of its existence among his cows. A few persons fix the date of its appearance in his stable as early as the year 1863. However, other dairy stables in the vicinity commenced to lose cows with the disease, when it was traced to Washington (see report of Washington). In 1866 Mr. Shipley succeeded Ross Winans in the dairy business. He used the same stable, having been told by Winans that no disease of any kind had ever existed on his premises. Shortly after taking possession Mr. Shipley noticed a few of his cows coughing, while others became short of milk and lost appetite. Eventually, 35 head of cows died. Mr. H. Merryman sustained a loss in this stable about the same time. Other dairymen commenced to suffer from its ravages. Outside of this city, all along the line of the Western Maryland Railroad, in Baltimore County, can be found stables where the disease has existed, and since the above time it has been transmitted from one section of the county to another. This was caused, generally, by buying infected animals at the Baltimore stock-yard, and by allowing animals from infected stables to pasture with healthy ones. We are now able to point out sections in different parts of not only this but other counties of Maryland, where periodical outbreaks of the disease occur annually. Sometimes these outbreaks are of a mild and at other times of a most malignant form. Baltimore city and its surroundings furnish infecting material for a wide extent of country.

CECIL COUNTY.

On May 9 I commenced my investigations of this county. Elkton is its county seat. The following day the members of the Cecil County Agricultural Society held a special meeting, which gave me an opportunity to converse with men who are anxious to aid the officers of your department in checking the spread of contagious pleuro-pneumonia. From Mr. A. R. Magraw, president of the society, I gained considerable information regarding the hygienic condition of cattle throughout the county. Elkton I consider free from the disease at present, although many cattle are brought here in the early fall from Baltimore to be wintered by farmers, and after being fattened are sent to Philadelphia and elsewhere for human consumption. A great many milch-cows are also sent here from the eastern counties of Maryland and from Virginia, thus avoiding to a great extent the infection which prevails about Baltimore. When we remember to what extent this city and vicinity is infected, it seems miraculous that any locality in the State should be so exempt as this. Mr. James Yates, three miles northeast of Elkton, informed me that, in 1879, he lost three cows with the disease, and from the history he gave me I concluded that such was the case.

On May 11 I visited a place called Brick Meeting House, where I found a recovered case of contagious pleuro-pneumonia, belonging to Levi Mearns, who bought some cattle at the Baltimore stock-yard, in company with a neighbor, Mr. Thomas Stevens, in 1879. Shortly after the arrival of these animals the disease developed itself among them, four head dying on Stevens', and three on Mearns' farm. A few recovered on each place, which were afterwards sold to a butcher who took them to Philadelphia. This small village is situated but a short distance from the State line between Pennsylvania and Maryland. From here I went to Rising Sun, which is still nearer the line, but could find no sign of the disease, although it had recently existed near this place in Pennsylvania, where it had been stamped out by the authorities of that State.

On May 12 and 13 I visited all the principal towns along the county line from Rising Sun to Perryville. During this investigation I visited many fine dairy farms and inspected a number of valuable herds, each herd consisting of from 20 to 30 head of milch-cows, but could detect no signs of disease among any of them. At Perryville

I found a gentleman named John Stump who, in 1879, lost 11 head of cattle by the disease. The disease was brought to his place by cattle purchased in Baltimore.

May 25, 26, and 27 I concluded the investigation of this county by visiting all of that portion lying south of the Philadelphia, Wilmington and Baltimore Railroad, commencing at Fredericktown and working north to Chesapeake. I failed, however, to detect a single case of contagious pleuro-pneumonia in this section of the county. At Chesapeake I found a few gentlemen who deserve great credit for the energy which they display in trying to exclude from this place all cattle from infected districts. Mr. John A. Harriot, member of the Cecil County Agricultural Society, seems to be the most active in this good work.

I will mention here that I visited a portion of Kent County called Galena. I made this visit because steamboats ran daily between Baltimore and Fredericktown. The two counties are separated by the Sassafras River. Thinking that an occasional infected animal might enter the county by these boats, I made a close observation of the cattle in this place, but I failed to detect the existence of any disease.

HARFORD COUNTY.

During the early part of June I visited this county, of which Bel Air is the county seat. I met prominent citizens who informed me of the existence of contagious pleuro-pneumonia among their cattle in former years. I visited all the towns and many farms, but failed to find a single case of the disease in the entire county. I was well pleased with the preventive means adopted by Colonel Stump and Dr. Magraw. In 1880 they received authority from the governor to appraise all animals infected with the disease, with authority to destroy them. Early last year Eldridge Gallop, who occupies the large farm belonging to the Citizens' Banking Association of Baltimore, brought a large herd of cattle to his place from the Baltimore stock-yard. Shortly after their arrival disease appeared among them, and four died in a few weeks. Not knowing the nature of the disease at that time, he commenced to treat the sick cows. Those which showed no symptoms of ailment were sold. Four such were sent into Pennsylvania, where they soon infected cows belonging to Mr. Pyle. This fact becoming known to the Pennsylvania authorities, they destroyed every sick cow and quarantined the stable. Mr. Gallop sold others singly to different parties in Abingdon, in this county. As soon as Colonel Stump and Dr. Magraw learned of the condition of these animals, they proceeded to kill every one of the cows that came from Gallop's infected herd. They then visited the infected stables and killed 22 head. Some animals had been sent to Baltimore previous to this slaughter, a fact unknown to these gentlemen at the time. In this herd 17 animals in all died from the effects of the disease. Since this transaction no further trouble has been experienced in this locality. I visited other sections of the county, where many herds of cattle are raised, and where large tracts of land are used for pasturing and wintering fat cattle. I think this latter pursuit is carried on to a greater extent in this county than in any other county in the State. The most of this grazing county lies along Deer Creek. Farmers in this locality frequently winter from 75 to 100 head each. The cattle pass through the Baltimore stock-yard previous to their arrival here. In the early spring they are sent to the Philadelphia markets. I was told that a Mr. Amos and son, who lived in the northern part of this county, had lost cattle from contagious pleuro-pneumonia. I visited their farm on the 7th of June, but from the history of the disease given me by the owner, I am satisfied it was southern cattle fever, a disease which prevails here occasionally, and generally causes heavy losses.

CARROLL COUNTY.

During the latter part of June I visited the different towns in this county, but I failed to find any case of contagious pleuro-pneumonia, either acute or chronic, until I reached a place called Manchester. After traveling a few miles north of this place I found a farm belonging to Barney Zepp, where the disease has existed since April 30. A short time previous to this he bought 3 cows from a dealer in this place, who buys cattle in all the different counties of Maryland and Pennsylvania, and sells them in most instances at the Baltimore stock-yard. At the time mentioned contagious pleuro-pneumonia broke out among them. Two showed the severe symptoms of the disease and soon died. The remaining cows were taken sick at different periods, and two died. I think the last two cases will recover. In 1875 they had an outbreak of the disease a few miles west of this place, in Bachman's Valley; cows from the Baltimore stock-yard caused this infection. The movement of cattle in the fall of each year from Baltimore here is similar to the movement of cattle into Harford County, only to a less extent. In the spring and summer months dealers drive most of the cattle to the Baltimore stock-yard, from which very few of them return during the latter period.

FREDERICK COUNTY.

On July 14 I visited Frederick City (county seat). The disease does not exist in this county at present. The most of the cattle brought here come from Virginia. The only place where the disease ever existed in this county is Woodboro, 12 miles north of this city. George Smith lost eleven head from its effects last year. None of those affected recovered. I am satisfied that Frederick County will remain free from the extreme ravages of the disease so long as such men as Dr. Fairfax Schley is at the head of the Agricultural Society. He is well versed in the nature of the disease, and is therefore enabled to explain to the members of his society the precautions necessary to prevent its spread.

ANNE ARUNDEL COUNTY.

I visited the principal city (Annapolis) and most of the small places in this county. No disease has existed in any of these places during the last three years. On the dairy farm of Mrs. Berry, one and a half miles northwest of Annapolis, a few animals died previous to the death of her husband, which occurred three years ago. Very few dairy stables that contain over 5 or 10 cows are to be found in this city. On its outskirts are a few farms stocked with valuable cattle. I was surprised not to find more of the disease here, because boats make daily trips to and from Baltimore, and often bring cows from the stock-yard in that city. Since the outbreak of the disease in Baltimore last year, however, most of the people in this county are very careful where they purchase their stock.

PRINCE GEORGE'S COUNTY.

During the early part of August and the latter part of September I made investigations in this county. Near the line of the District of Columbia, I found the disease had existed in previous years. I could detect no cases at present. In the year 1879, David Campbell, dairyman, three and three-quarter miles southeast of Washington, in this county, contracted the disease among his cows by purchasing an animal affected with it, from Mr. McDowell, of Washington. A veterinarian was sent from the latter place, who advised Mr. Campbell to destroy his cows. Two of them were killed, two others died, and the remainder were sold. A man named Brooks, who lives one mile south of this infected stable, lost two cows by the disease. They were infected by Mr. Campbell's cattle. I found other farms where the disease had existed in the District of Columbia, near the county line, which I shall mention in my report of the District.* All of that section of this county bordering on the eastern line of the District of Columbia has been liable to more or less of the disease among the dairy cows since its appearance within the District. This is especially so as regards the dairy cows along the Baltimore and Ohio Railroad. A few miles from Washington, near Benning's Bridge, I found a farm where the disease existed in 1878. The place belongs to W. B. Lacey, who lost 13 head of cows at that time. Those that recovered were sold. There is no disease on his place at present.

MONTGOMERY COUNTY.

On August 10 I visited Rockville, the county seat. I could find no one here who ever heard of the existence of the disease, except near Sandy Springs, which is situated near the border line between this and Howard county. I have been in most of the towns of the county, but I have failed to detect a single case. At Sandy Springs, in the year 1876, Dr. Thomas and his brother Edward, who have adjoining farms, experienced a mild form of the malady among their cattle. The disease was communicated by a cow purchased in Washington. Other owners of cattle in this locality also suffered losses among their stock, among them Philip Stabler and Wm. Moore. The latter's farm is located two miles west of Sandy Springs. All of that portion of land lying west of the Metroplitan Railroad, and bordering on the Chesapeake and Ohio Canal, is used as pasture for fattening cattle. Since the termination of the war a great many cattle have been bought from men in Southwest Virginia and afterward pastured in this locality until they were fit to send into the market. Very few come from either Washington or Baltimore, and the danger of infection is therefore greatly lessened.

DISTRICT OF COLUMBIA.

I consider the District of Columbia and a portion of Virginia as liable to periodical outbreaks of contagious pleuro-pneumonia. It has existed in this locality since 1864, and is in about the same condition as Baltimore city and county. I made repeated visits to this section in the months of August and September, and found one or more cases during each visit. On August 11 I visited the north end of Washington, a locality commonly called "Cowtown," where I found a small portion of inhabitants owning a greater or less number of dairy cows. Near by is a large commons where most of these animals are pastured. During one of my visits in this locality I detected a cow with all the symptoms of an acute form of the disease. It was owned by Mr. Hollidge, who lives on Sherman Avenue. In the same stable I found a chronic case. This animal formerly belonged to his brother, who kept a dairy stable, two months previous to this time, on Spring road, about one and a half miles north of the boundary line of the city. This gentleman became disheartened by the loss of cows affected with the disease, and sold out. Those bought by his brother showed no symptoms of the disease at the time of purchase, but it developed itself in this cow after her arrival. This man lost heavily in cows in the year 1871.

Mr. McKay, who keeps a dairy stable on Ninth street, one-half mile north of Boundary street, bought 7 cows from Mrs. Seidenberger, who was anxious to sell, as she lost 4 cows by the disease last February. Her stable is located near the infected stable on Spring road, which was used by Mr. Hollidge. McKay denied the existence of the disease among his cows, but 3 of them have disappeared in some way unknown to me. I wish to mention here that it is useless for me to watch any of the stables where I find the disease so long as we have no power to destroy the affected animals.

Mr. Harman lives at Mount Pleasant, about one mile north of Washington. On the 30th of September I found a cow in his stable suffering with the disease. Previous to my visit Dr. C. P. Lyman had visited this stable and found a heifer calf suffering with the disease in an acute form. It died the same day. An autopsy was made and a portion of the right lung preserved. On the same day I visited a stable owned by Robert Brown (colored), who lives a short distance south of Mr. Harman's. I found one of his cows sick with the disease. This man says that the disease has been on his place since 1875, and that he has lost several cows by it.

On October 1 I was refused admittance to the stable of Mr. Shugrew, which is located a few hundred feet south of Mr. Hollidge's. One of his animals was undoubtedly sick. The rest of them, 14 in number, were running at large. As I was unable to see the sick animal I could not decide as to the nature of the disease. Since 1871 this man has lost 30 cows by the malady.

On October 3 I visited the commons about Mount Pleasant. Among a large herd of cows, which belonged to different owners, I found several recovered cases. I also discovered a very acute case in a field adjoining these commons, which I learned belonged to Robert Hays. Six other cows were with her. I thought it important to make this case known at once to the department, in order that some one else would go and examine it. From the time of the discovery of this animal until my return in company with a representative of the department, which was but two or three hours, the cows had been removed to their stables in "Cowtown," near Seventh Street and Boundary, and the sick animal exchanged for a healthy one. When questioned, the owner could not give the residence of the dealer with whom he had exchanged the cow. He acknowledged that he had lost 30 cows by the disease since 1871.

On the same day I visited the stable of Captain Viall, Meridian Hill, northwestern boundary of Washington. This place has been infected since 1876. During this period he has lost 28 cows. Two have died since last June. One animal is still living, and has been running at large for the last two months. She is liable to spread the disease among other animals.

October 7 I walked over the commons on the eastern part of the District of Columbia, where most of the cows in this section graze. I detected one cow among them sick with the disease, and concluded to follow her to the stable, situated on D street between Eighth and Ninth, northeast. Mr. Callahugh, the owner, acknowledged having had four cows affected with the disease. Whenever they commenced to grunt or showed severe symptoms he disposed of them to the butchers. He said he intended to dispose of this cow in the same way if her appetite did not soon return. I found her temperature to be 103½° F. He noticed his first sick cow in the month of June, and has been troubled with the contagion among his cows up to this date. At the beginning of this outbreak he owned seven cows. Five of them have been affected. Other people in this locality have lost a few cows lately. L. Obenstein, who lives one square east of Callahugh's stable, lost one affected with the disease last week. Mr. Bresnaham, C street between Eighth and Ninth northeast, lost one cow affected with the disease during the month of September; also Mrs. Clancey, on Fifth street between North A and East Capitol street, lost an animal in the month of August. Since 1870 this lady has lost 60 cows by the disease.

The disease in the District of Columbia prior to 1881.

Name of owner.	Locality of infected stables.	Number of deaths.	Year.
Mrs. Keefe	910 Twentieth street near K street, Washington	4 cows	1864
Michael White	Seventh street near Boundary	20 cows	1869
Mr. Hollidge	Sherman avenue, Boundary, Washington	Unknown	1871
Owen Shugrew	do	30 cows	1871
Mrs. Morrisy	Seventh street near Boundary, Washington	14 cows	1871
Robert Hays	Boundary street near Seventh, Washington	30 cows	1871
Mrs. Clancey	Fifth street between North A and East Capitol streets, Washington.	60 cows	1871
William Davis	Corner of T and Twenty-seventh streets, Washington.	23 cows	1873
Mr. Harrington	No. 3418 First North street, Georgetown	20 cows	1875
Mr. Kay	2 miles southeast of Washington, Marlborough road.	28 cows	1875
Mr. Holden	2 miles southeast of Washington, Marlborough road.	Unknown	1875
Mrs. Schench	Corner of Seventh street and Rock Creek road, Washington.	40 cows	1875
Mr. Andries	Tenallytown near Washington	12 cows	1876
Mr. Bangerter	do	Unknown	1876
Captain Viall	Meridan Hill, northwest of Boundary street, Washington.	28 cows	1876
Mrs. Blagden	Fourteenth street, 2 miles north of Washington	5 cows	1877
Benjamin Green	Fourteenth street, 2 miles north of Washington	2 cows	1877
Mrs. R. Hamilton	Fourteenth street, 1 mile north of Washington	5 cows	1877
Mr. Nehman	Tenallytown, D. C	14 cows	1877
Mrs. Kelly	Corner of G and Twenty-fifth streets, Washington.	16 cows	1879

SUMMARY.

The result of my investigations enables me to give the following summary:

Number of cattle examined since March, 1881	11,270
Number of acute cases of disease found since March, 1881	110
Number of chronic cases of disease found since March, 1881	41
Total number of diseased animals found since March, 1881	151
Number of deaths that have occurred since March, 1881	67
Number of deaths reported as having occurred since 1864	1,029

Respectfully submitted.

W. H. ROSE, *D. V. S.*

BALTIMORE, MD., *November* 1, 1881.

REPORT OF THE ENTOMOLOGIST.

INTRODUCTION.

SIR: I have the honor to present herewith the following report of some of the work done by the Entomological Division during the fiscal year now drawing to a close. The report necessarily covers but a small portion of the work done or being done, and is devoted to some of the more important observations and experiments of a practical nature on such subjects as have received especial attention, viz., Silk-culture, the Cotton Worm, the Chinch Bug, the Army Worm, the insects affecting the Orange, those affecting Rice, some new depredators on Corn or Maize, and various miscellaneous insects that have attracted more than usual attention during the year.

While I have not hesitated to embody matter of scientific interest and even descriptive matter when necessary to give greater accuracy to the information to be conveyed, yet lengthy descriptive papers have been eschewed on the ground that these reports are intended for the practical man rather than as contributions to entomological science.

It is not necessary to draw your attention specifically to the contents of the following pages, nor to the important practical discoveries which they refer to. To do so would not add to their value. But a few words as to the general work of the Division, with such suggestions as experience indicates, will not be inappropriate in submitting the report.

Four years ago, when first called to act as Entomologist to the Department, I found provision made in the annual appropriation for but one person who, in addition to a clerk allowed from the clerical force and known as the assistant entomologist, constituted the Division. Under such conditions it is not surprising that little was attempted in the way of original research of a practical nature. The surprise is, rather, that Mr. Glover accomplished as much as he did during his long connection with the Department.

The evil from insects injurious to the various crops of the country is a great and growing one which none more fully appreciate than the cultivator himself. The aggregate annual loss to the nation from insect depredations amounts to hundreds of millions, and there is a loud call for relief; but relief can come only by a combination of accurate entomological knowledge with extensive field work and experiment, and this last is possible only with men and means. My first step, therefore, was to get an increase of means so necessary to such work, and I at once began some special investigations looking to the control of a few of the worst of our insect pests. The Division was reorganized on a more practical basis, and my successor continued the work that had been planned and begun.

The great increase in the correspondence of the Division may be judged of by the fact that during the past year over 2,000 letters of inquiry have been received, most of them requiring full replies, so that, in fact, over 1,800 letters have been written. This correspondence constitutes a very large part of the work of the Division, and demands most of the time of myself and office assistants. A large proportion of the letters received make inquiry regarding some of the commonest and best known insects. This dissemination of special information to individuals is, I conceive, one of the chief functions of the entomologist, yet one of infinitely less importance to the country than original research and discovery; and as such routine correspondence, even with the most economical division of labor among the present office force, has more and more absorbed the time of the Division to the detriment of field work and experiment, my aim has been to gain more time for this last part of our work without impairing the efficiency of the Division in the matter of said correspondence.

As greatly helping to this end I have begun, with your approval, the preparation of a series of special Bulletins on the most widespread and important of our injurious insects, each intended to contain a complete account of all that is known in reference to some particular insect or some particular set of insects affecting a given crop. Such Bulletins—concise, so as to be readily mailed, written in popular style, and amply illustrated—will greatly facilitate the correspondence, by rendering unnecessary the constant repetition of letters giving detailed information to the various correspondents who make inquiries about one and the same species.

A Bulletin on the Northern Army Worm, one on the Boll or Corn Worm, and one on Canker Worms are prepared and ready for the press, while others on Cabbage Insects, and on the Chinch Bug are in preparation. If stereotyped, these Bulletins can always be kept in supply, and limited editions only need be published at any one time.

I would recommend further, as a means of increasing the usefulness of the Division, that, in addition to the special Bulletins above indicated, a periodical Bulletin of the Division be issued touching general entomological matters of current interest. Many contributions of value, whether from voluntary correspondents or special field agents, are placed on file in the Division archives, and they are either not made public at all or are used in the Annual Report, which appears long after they have lost much of their timely interest. With such a system of publication as I have indicated, added to the special reports ordered by Congress, the work of the Division would be rendered more effective. Three special reports are in course of preparation, viz., a Bibliography of economic entomology, a report on the insects affecting the Orange tree, and a report on forest tree insects. These will be too bulky to be issued as Bulletins, or to be included in the Annual Report, and should be ordered printed by special act of Congress.

The United States Entomological Commission, which was by act of Congress attached to the Department at the beginning of the fiscal year, has not attempted any field work, but has been closing up its office work in accordance with the spirit of the last appropriation act. Bulletin 7, by Dr. Packard, on forest tree insects, has been issued, and the third and fourth reports of the Commission have been completed and are ready for the printer.

As we now have near by, and of easy access, a National Museum admirably fitted for the preservation and exhibition of natural history specimens, and as the Director thereof is authorized by the organic law to claim any collections made by the various other Departments of the government,* I have decided, with your approval, to devote as little time as possible to pure museum work, limiting it to the preservation of such material as will best illustrate the habits of those insects which interest the farmer. In this direction a large number of species have been reared, studied, and mounted, so that those treated of in the report form but a fraction of the number actually studied. In systematic museum work I hope rather, as curator of Entomology in said museum, to co-operate with Professor Baird in his efforts to bring together a national collection of insects, and to this end have deposited with him my own private collection. It is thus more safe from fire than it would be in the Department, and at all times accessible when needed, as is constantly the case, in the work of the Division.

I have been assisted during the whole of the year in my office work, and in the preparation of reports, by Prof. W. S. Barnard, Mr. L. O. Howard, Mr. E. A. Schwarz, and Mr. Theo. Pergande, and since September by Mr. B. Pickman Mann; and these gentlemen, together with Mr. A. Koebele, who has aided part of the time in the office work, deserve my praise and thanks for the uniform industry and interest which they have manifested in the work assigned to them. The same is to be said of the agents and observers in different parts of the country. Mr. H. G. Hubbard has had charge of the Orange insect investigation in Florida, and Mr. Laurence Bruner of the work in relation to the Rocky Mountain locust in the Northwest. Dr. J. C. Neal, of Archer, Fla., Dr. E. H. Anderson, of Kirkwood, Miss., Mr. W. E. Martin, of Oxford, Miss., Mr. J. G. Barlow, of Cadet, Mo., and Miss M. E. Murtfeldt, of Kirkwood, Mo., have each made special observations for the Division, under instruction, during some part of the year, while my predecessor, Prof. J. H. Comstock, has been engaged at Ithaca, N. Y., on a special report, for which he took with him all the notes of importance (with duplicate

*Revised Statutes, § 5586; Statutes Forty-fifth Congress, third session, chap. 182, p. 394.

specimens) that had accumulated during his administration. His report, just submitted, consists chiefly of a monograph of the *Diaspinæ*, a subfamily of the scale-insects. This monograph includes the species already treated of in the last Annual Report of the Department, as well as many foreign species, and, at your request to curtail, for want of space, I have excluded it. The rest of the report is included herewith. Considerable matter of my own, has, for the same reason, been excluded.

The wood-cut illustrations are some of them from my own pencil, but have most of them been drawn by Mr. George Marx, under my direction. The photo-engravings illustrating Professor Comstock's report have been drawn by Mrs. Comstock, who, together with Mr. H. W. Turner, assisted him during the year. The colored plates are painted from nature. Where the figures are enlarged the natural size is indicated in hair-line or in some other way.

Respectfully submitted June 30, 1882.

C. V. RILEY,
Entomologist.

HON. GEO. B. LORING,
Commissioner of Agriculture.

EXTRACTS FROM CORRESPONDENCE.

The following extracts have been made from the miscellaneous correspondence as containing entomological observations of interest not included in the balance of the report. They could not be extended so as to include all such observations made by correspondents without trenching on the report proper; while the voluminous correspondence from special agents will, much of it, be used elsewhere. The references in brackets are to the Letter Files, by number and page, to facilitate future use of the full communications:

On July 2d, W. F. Holmes, of Cypremort P. O., Saint Mary's Parish, La., sent a new enemy of the sugar-cane, with statement that it eats the heart of both stubble and plant SUGAR-CANE and of CORN, and hides in the very lowest part of the heart, causing its death and decay. The specimens sent were larvæ of noctuid moths, but were all dead, so that it was impossible to determine them more exactly It is evidently a new enemy. [L. F. 5: 180.]

On August 11th, R. M. Sims, Columbia, S. C., sent specimens of a species of *Podura*, which "came out in myriads from the ground at the State Penitentiary, from beneath brick drains, walls, &c." [L. F. 5: 182.]

On July 20th, T. J. Davis, of Rixeyville, Culpepper County, Virginia, sent eggs of *Clisiocampa americana*, which he found on twigs of PEACH TREES. [L. F. 5: 217.]

On August 15th, Wm. Fairweather, of McLane, Erie County, Pennsylvania, wrote that his apple crop, in an orchard of 6,000 trees, had suffered greatly from the ravages of *Anthonomus quadrigibbus*. "Some trees will hardly have an APPLE but what is dashed and dotted all over by the proboscis of the Beetle pest." [L. F. 5: 255.]

On August 31st, J. A. Gundy, of Lewisburg, Pa., sent heads of CLOVER, infested with *Cecidomyia leguminicola*, from his locality. [L. F. 5: 263.]

On October 4th, Dr. D. H. Webster, of Austin, Mo., wrote that the Chinch Bugs had done a great deal of damage to the wheat and corn crops in his locality in 1881. [L. F. 5: 291.]

On October 13th, Theo. G. Fowler, of Uniontown, Ala., sent specimens of *Strachia histrionica*, with an account of their ravages on COLLARDS, TURNIPS, CABBAGES, and RADISHES; and *Phakellura hyalinitalis* which had riddled the leaves of the SQUASH VINES. [L. F. 5: 310.]

On October 4th, H. C. Meyer sent specimens of *Calandra oryzæ*, which had been distributed in seed corn by the Department. [L. F. 5: 330.]

On October 20th, J. E. Willet, of Macon, Ga., sent specimens of *Oncideres cingulatus* which had been girdling the twigs of ENGLISH WALNUT. [L. F. 5: 365.]

On October 25th, J. G. Barlow, Cadet, Washington County, Missouri, sent specimens of *Isosoma** which had been found, pupated, above the first or top joint of wheat straws. "The crops that were infested by the worm were very poor, and grew mostly in fields that had been sown in wheat four or five years in succession." He sent also specimens of *Silvanus advena* and *Typhæa fumata*, which he said he found earnestly at work upon CORN in stack, eating the grain, with their heads in the small hole at the bottom of the excavation. [L. F. 5: 376.]

On November 7th, he added that more than two-thirds of the wheat straws in the field had a larva or pupa of the *Isosoma* in them, and the crop was sadly diminished by them. One farmer had 15 bushels off 9 acres, another sowed 15 bushels of wheat and harvested only 30 bushels; another harvested 6 bushels from 10 acres. [L. F. 5: 393.]

On November 16th, Gabriel A. Fournet, of Lake Charles, La., sent specimens of *Parlatoria pergandii*, which he stated had first appeared for the season on the leaf of ORANGE TREES since the first of the month. "Since four or five years this insect has made its appearance and *completely* destroyed the valuable orange groves which form the principal source of the value of the land here." [L. F. 5: 405.]

On November 7th, Almond Maxson, of Minden, Sanilac County, Michigan, sent specimens of *Calandra granaria*, which had been distributed by the Department in SEED WHEAT to the sufferers by the Michigan fire. It is presumable that the fire had ridden the district of all these pests, so that it was particularly unfortunate that the Department should have been the means of reintroducing them so promptly. [L. F. 5: 427.]

On November 19th, Evan J. Prothro, of Richland, Stewart County, Georgia, sent specimens of an undetermined species of *Oethus*, stating that they had injured CHUFAS early in the spring. [L. F. 5: 465.]

On November 14th, W. Cornell Caywood, of Marlborough, N. Y., sent, in response to a request, specimens of *Phloeotribus liminaris*, upon whose ravages on PEACH TREES he wrote in the *Rural New-Yorker* of November 12, and again in the same paper later. [L. F. 5: 480.]

On November 21st, he wrote: " * * * If it is recorded as injuriously affecting PEACH TWIGS it has evidently changed its point of attack, as it in no instance attacks the smaller branches or twigs, nor even one-year-old trees, and very seldom two years old; if they do the number is so small that they do but little injury. We see them on three-year-old trees, but in killing numbers on four years old and older. Since sending the account of this insect to the *Rural New-Yorker*, by further examination we find they infest all the cultivated and WILD CHERRIES and PLUMS. We found a cherry tree six years old as effectively killed as the PEACH TREE we sent you by express." [L. F. 5: 481.]

On January 21st, Matthew Cooke, chief executive horticultural and health officer of California, Sacramento, Cal., wrote: " * * * From practical experiments we have proved beyond a doubt that a successful warfare (against insects) can be accomplished. I have no hesitation in saying that Santa Clara County will increase her produce of choice marketable fruit from 75 to 100 per cent. this coming season. The remedy most favored there at present is coal oil. However, I dare not recommend it, as ignorant parties might attempt to use it and destroy the trees. I will take the liberty of giving you the experience of a gentleman owning an orchard two miles from San José, Santa Clara County:

"George W. Rutherford owns extensive mining interests in the State of Nevada, and therefore cannot be classed as a practical fruit-grower. He bought an orchard two years ago at San José at a cost of $32,000. The crop of 1881 was badly infested by the Scale, *Aspidiotus perniciosus*. When Mr. Rutherford came from Nevada this last fall he was willing to sell his orchard (Scale Bugs included) for $15,000—no buyer. He was not in favor of coal oil, but bought four tons of lye of American Company. When he had his orchard two-thirds washed his neighbors told him he had destroyed his trees. He requested me to go there and see what had been done. I went to his place on the 28th December. He had killed nearly every Scale Insect and Red Spider on his trees so far as he had washed, and every tree showed a healthy green layer. He now asks $50,000 for the orchard. The whole cost of cleaning, including 5 tons of lye, will not exceed $1,000. Others are very successful with coal oil.

On January 31st, George Pitts, Iuka, Marion County, Illinois, wrote that in the previous year the Chinch Bugs killed all the CORN. They were so numerous that the wheels of a wagon were quite wet and gummy with killing them in going a mile or two on the road. [L. F. 6: 68.]

On January 8th, J. G. Barlow, Cadet, Washington County, Missouri, sent specimens of *Aphodius lutulentus*, which had been injuring grains of CORN contained in cow-dung. [L. F. 6: 118.]

* See the article *Isosoma tritici* in another part of this Report.

On January 6th, E. N. S. Ringueberg, Lockport, N. Y., sent (through A. S. Packard, jr.) larvæ of *Cecidomyia leguminicola* which had infested several clover-fields in his vicinity in the previous fall. He writes: "One farmer said that in thrashing the clover all that came was nearly clear weevil (as they call them)." He writes further: "A few years ago I sent you (Packard) some eggs that were destroying the bearing wood (canes) in my father's vineyard, which you determined to be *Oecanthus niveus*, adding that they hatched in May. Since then I have had the wood trimmed and burned before that time (first of May), and now can say that the result is very favorable, as I should estimate a reduction of from one-third to one-half as many injured as formerly." [L. F. 6: 148.]

On February 18th, Caleb Gilman, Meddybemps, Washington County, Maine, reported that he had used a soap-washing at the time of the hatching of eggs of Apple-tree-bark lice successfully in the destruction of the pests. [L. F. 6: 159.]

On February 14th, Charles Mohr, of Mobile, Ala., sent larvæ of *Diatræa sacchari*, saying: "The crops of the sugar-cane on the seaboard in this county have been almost entirely destroyed by it last season, as well as the season before. As far as I could learn it is only since the past three, or at the most four, years that this enemy to the sugar-cane has made its appearance in this region, proving worse with every succeeding one. It affects mostly the crop raised in the lowlands, with a heavier subsoil, richer in vegetable matter, and more or less deficient of drainage. The cane grown in the porous sandy soil of the rolling pine lands has so far suffered but little from it. The larva commences its borings in the latter part of the summer, when the lower joints begin to ripen; before reaching their full growth and maturity the canes are perforated to a degree which causes them to be broken down under every gale of wind." [L. F. 6: 216.]

On February 25th, Prof. A. E. Blount, of the Agricultural College, Fort Collins, Colo., sent specimens of *Lygæus reclivatus*, with the statement that they live and seem to hatch all winter and summer in the cracks of brick and stone houses. "It flies readily all winter in buildings where there are fires. I have seen it eat nothing but dead flies and mosquitoes." In response to a statement of the known habits of this insect, Professor Blount asserts, March 13, "I am prepared to state on my own observation, and on other reliable information, that 'my bug' lives upon DEAD FLIES, mosquitoes, and other insects found in and about buildings. No less than 50 males and females live and breed in my room the year round. They come out from the cracks of my floor any day to see me, and from certain cracks in the brick wall outside they come and bask all day in the sunshine. They have no vegetable within reach at all. I can find nothing in my room they touch or injure, nor have I or any one of us ever seen a single specimen away from the buildings. Young specimens can be seen all winter long in my room. When trodden upon they made a 'fearful' grease spot." [L. F. 6: 465, 605.]

On March 24th, J. B. Quill, statistical correspondent, Burlington, Coffey County, Kansas, sent specimens of pease infested by *Bruchus pisi*, which had been contained in seed sent out from the Department. [L. F. 5: 607.]

Miss M. E. Murtfeldt, of Kirkwood, Mo., gave the following notes of the season:

"Cutworms were not so numerous as usual early in the spring, but few of the hibernating larvæ probably surviving the excessive cold and the changeable weather of February and March. The succeeding brood, however, was quite destructive to early vegetables.

"*Tenthredinid* pests were very numerous during May and June. The Rose slug, the Raspberry slug, and the Plum slug were uncommonly destructive. The foliage of the oaks and willows was also much injured by the various species peculiar to these trees.

"The 13-year brood of Cicadas were heard about the 20th of May, and the woods resounded with their peculiar music until nearly the last of June. About one-third of the specimens examined were of the small form (*C. cassinii*, Fisher). The notes produced by this variety are much finer and shriller than those of the normal form, but I was not able to observe any other difference. The punctures were made mostly in the oaks, the undergrowth being injured more than the large trees. Some of the large orchards suffered slightly, but as a rule the insect did little damage in this locality.

"The Great Elm-leaf beetle (*Monocesta coryli*, Say) appeared in unusual numbers toward the end of June. It is strongly attracted by lamp-light and would swarm into brightly-lighted rooms of evenings in such numbers as to be a great nuisance. Its larvæ were to be found on the slippery elms during the month of July, and I afterward observed a few leaves on the American elm skeletonized in the characteristic manner of this insect; but as I did not find it at the work, I cannot be positive that it feeds upon any other species of *Ulmus* than *fulva*.

"As there were no peaches and very few cherries and plums the Plum curculio had but little opportunity to multiply, and even the few stone fruits that we had were not much affected. A year ago I bred several specimens of this curculio from gooseberries. There were none of the latter, however, this season.

"The Codling moth also was rather rare this year in Kirkwood. It would seem that the heat and drought of July and August must have prevented, in a great measure, the emergence of the second brood of moths, since the later apples, though otherwise of poor quality, are almost free from worms.

"So far as I was able to observe there were, this year, no Phylloxera galls on the leaves of those varieties of grapes usually most subject to them, and a thorough examination, in September, of the roots of Clinton, Taylor, Concord, and Herbemont failed to reveal either the insects themselves or any evidence of their recent work. Perhaps the long-continued drought was inimical to them.

"The Grape-berry moth (*Eudemis botrana*, Schiff) was very abundant, causing nearly all of the so-called "rot" that appeared in this vicinity this year.

"*Psychomorpha epimenis* (Drury) and the Grape vine Plume injured the buds and foliage to some extent early in the summer, while *Procris Americana* and *Desmia maculalis* were very destructive to it later in the season. I have found the last-mentioned insect especially partial to the leaves of the Herbemont and similar thin, smooth-leaved vines. Upon these its ravages were very severe, scarcely a leaf escaping. Pyrethrum powder will kill the larva when it can be made to reach it, but dusting the outside of the leaves within which the depredators are securely folded is an expensive and profitless process.

"All species of Blister beetles were, this summer, conspicuous by their absence. Plants that usually suffer greatly from the attacks of the Margined and Striped beetles (*Epicauta cinerea* and *E. vittata*) enjoyed this season, in this locality, complete immunity. I have not been able to discover the cause, unless it was due to the drought."

SILK CULTURE.

The correspondence and labor of the Division in the promotion of silk culture this year has consisted in the distribution of eggs imported from Japan for the purpose and the conduction of a large correspondence with persons inquiring about the adaptation of their several climates or localities and of several kinds of trees to the prosecution of the industry, as well as making numerous other inquiries upon the subject.

The distribution of eggs was begun in the last week of January, (1882), but unfortunately a number of the eggs were already hatching when we received them from Japan, owing to their exposure to heat while on the way, and they continued hatching for a considerable time afterwards.

As yet few returns from the experimenters of this year have come in. The reports received indicate good success wherever eggs were kept unhatched until the leaves of the food plants were sufficiently developed for use, and no especial mishap befell the brood.

Mr. L. S. Crozier, who established himself at Corinth, Miss., during this fiscal year, as manager of the Corinth, Miss., Silk Company, has been the most constant of our correspondents respecting silk culture. In a letter of January 14, 1882, after relating his experience as a silk-culturist, first in France, then as director of an investigating committee, sent out by the Agricultural Society of the Department of Ardèche to visit the Levant in search of healthy breeds of Silkworms (where during eight years he visited Turkey, Wallachia, Asia Minor, Syria, the Caucasus, Persia, and Japan), and finally, during ten years, in Kansas, Missouri, North Carolina, Louisiana, Mississippi, and elsewhere, he says that he has come to the conclusion that none of the silk-growing countries he has visited is better adapted to silk culture than our Middle and Southern States, adding:

Our reeled silks were sold in Ardèche, France, where the best of the world are raised and prepared for Lyons weavers, at 130 francs per kilogram, our cocoons at $6 per kilogram, the highest price paid that year for first-rate silks and cocoons. My cocoons and silks exhibited at the Paris Exhibition in 1878, in competition with all the best products of the world, caused many Italian and French firms (silk millers, reelers, or dealers in silkworm eggs) to offer me the best prices of the time for our goods, eggs, cocoons, and reeled silks—white, yellow, and citron-colored. Can we not now say not only that silk growing is a success in the United States, but that American-grown silk is of first quality when raised under good conditions? Why, we attain the prices of $8 to $9.50 per pound in competition with Japanese and Chinese silks worth from $5.50 to $2.50 per pound.

And then he goes into speculation about the future, where we will not follow him. He counsels, however, that silk culture should only be taken up as an addition to general farming.

Mr. Edward Fasnach, of Raleigh, N. C., in a letter of January 27th:

You are doubtless aware that the "Systême Pasteur" has proven so effective a prevention against the *pebrine* that silkworm eggs produced by this method are giving very satisfactory results, so much so, indeed, that with the improved and more intelligent mode of rearing the silkworm, results are now obtained that far surpass those of former years when the *pebrine* had not made its appearance. The consequence is the demand for foreign eggs is growing less every year, and the American silk grower must needs more than ever look for a home market. This brings to mind your suggestion for the establishment of a filature so ably set forth in your admirable pamphlet. There is a wealth in our numberless mulberries and *Osage orange* growing almost everywhere in our broad land, that awaits only the filature, and, like the magic wand, it needs but to "strike the rock and bid it flow."

ASSOCIATIONS.

A ladies' association was formed at Spring Hill, near Mobile, Ala., this spring (1882). Miss A. C. Gronn, secretary.

The Women's Silk Culture Association of California was organized in 1881 to promote the revival of the silk interest in California. It distributed circulars of information, and eggs, and mulberry cuttings to those persons who were willing to undertake the rearing of silkworms. The new year's issue (1882) of the Sacramento Record-Union contains a report by Mr. Theodore Hittell, president, *fide* Jeanne C. Carr.

We believe it was under the auspices of this association that an offer was made through the newspapers to send 400 or 500 eggs to any part of the country upon application to Felix Gillet, Nevada City, Cal., inclosing a three-cent postage stamp.

The Women's Silk Culture Association of the United States, whose office is at 1328 Chestnut street, Philadelphia, Pa., was organized in April and incorporated May 31, 1880, for the purpose of establishing "Industrial schools for instruction in the art of silk culture, and in the art of preparing silk for manufacturing uses; and the establishment of auxiliary associations for such instruction throughout the United States." During the year following its organization it brought the subject of silk culture before several other associations promotive of agriculture, besides giving instruction in rearing worms and reeling silk at its rooms in Philadelphia, and during the past year it has distributed a large number of eggs, mulberry trees, and pamphlets, bought cocoons, from which it procured the reeling of the silk, and held an extensive and well-attended fair in Saint George's Hall, at the corner of Thirteenth and Arch streets, Philadelphia. To this fair we contributed several cases of goods illustrating native and foreign reeled silk and cocoons.

As an earnest of the encouragement which the association tenders to native producers of silk, and of the practicability of silk culture in all its branches in this country, the association procured the manufacture of a silk dress for Mrs. Garfield from silk raised in fourteen States, reeled at the rooms of the association, and dyed and woven by Hamil & Booth at their mills in Paterson, N. J.

An institution, under the name of the American Silk Exchange, was incorporated in New York on the 9th of May, 1882, and proposed to open formally for business on the 20th of that month. "Its object is to organize a market for American silk producers, and to encourage silk-worm culture in this country." The president says that if the mills will not buy the silk which the exchange will have for sale it proposes to start a mill of its own. To attract public attention the exchange prepared to open, on the 5th of June, and to continue until September, a silk exhibition, at which every step in the culture of silk would be shown, the cocoons being unwound and the silk spun and woven in the hall.

SALES OF EGGS AND COCOONS.

Mrs. John Lucas, formerly secretary, and now president, of the Woman's Silk Culture Association of the United States, 1328 Chestnut street, Philadelphia, Pa., wrote, March 11, 1882:

I find it difficult to discover the statistics you need for your report, but I feel assured there are some quite large lots (of cocoons) that we know have been raised that the culturists keep back, hoping to obtain a higher market at the great silk depots of France. * * * The sales of waste cocoons have been about 130 pounds, the price paid $1 per pound. Some inferior and stained and badly cured whole cocoons brought 50 cents to 75 cents per pound. Of whole cocoons we have received about 250 pounds. We have reeled 100 pounds of whole cocoons, for which we have paid from 90 cents to $1.15 per pound. Some few choice cocoons here brought more, as we gave a price for them as samples. Your figures of $1 to $1.50 I think are quite safe, but we could not pay $1.50 per pound and then pay $1 per day to reel and cover ourselves. You see this $1 per day and city expenses is not a criterion for home industry. * * *

(Additional) 30 pounds of inferior waste purchased; 10 pounds of whole cocoons, 30 ounces of eggs, and 60 pounds of waste produce at our rooms. About 25 pounds of reeled silk obtained from the 100 pounds of cocoons reeled.

REPORTS.

Many of the reports received from persons to whom eggs were sent contain no information which is of service for instruction.

Mr. Andrew J. Coen, of Jackson Station, Daviess County, Missouri, reported (February 1, 1882) that most of the eggs sent him in 1881 were hatched when received, and in the absence of any proper food, the trees not having leaved out at the time, he tried feeding the worms on cabbage leaves; at first they seemed to relish that food, but soon began dying, and all died. He only kept one egg unhatched until the proper season, and from that he obtained a cocoon.

Mr. G. Damköhler, of Clarence, Shelby County, Missouri, writes (February 4, 1882), that he fed the Silkworms only on Osage orange, and knew nothing of the business except what he had learned from the manual. Mr. E. Fasnach, of Raleigh, N. C., pronounced his silk superior.

Mr. S. Wrotnowski, of Baton Rouge, La., an experienced silk culturist, formerly proprietor of a *magnanerie* in Puy-de-Dôme, France, sent a model report May —, 1882, of his experiments in raising worms on the *Morus multicaulis:*

Taking the product of one day's hatching (February 7), keeping them at a temperature ranging between 22° and 28° C. (72° and 82° F.), with a moisture between 60° and 70° C., and feeding them from four to six times per day on leaves of *Morus multicaulis*, they entered their second age on the 7th day, their third on the 13th, their fourth on the 20th, their fifth on the 28th, and mounted to spin on the 35th day, March 13. The moths reserved for seed came out of the cocoons and began to lay eggs April 1; most of the cocoons were smothered in a stove at a temperature of 90° C. (194° F.).

During all the time of rearing no one of the worms died or was sick, but all came to maturity in good health. They made the best cocoons that can be made and the finest quality of silk, as you can judge by the sample that I have the honor to send you by this day's mail in a paper box. By this experience and another, made in 1860, with the same success, I can annul the prejudice against *multicaulis*, that its leaves are too watery and are unhealthy for the worms, and consequently cannot produce good silk This is completely erroneous. If during long rain the leaves become too wet I passed them between dry cloths and sprinkled with powder made of leaves dried in the sun or on a stove; if they had been gathered some time and were faded or dry, I sprinkled them with water and mixed and then served them to the worms.

While a student, about the year 1839, in the French institution, "Ferme expérimentale des Bergeries de Senart," near Paris, of which M. Camille de Beauvais was at that time director, we endeavored to obtain cocoons from *multicaulis*, but the frost always destroyed the leaves, and the trees in that climate cannot endure the frost. But, here, in several States of the South, they prosper admirably; we have many large trees two feet in diameter.

About four years ago I planted *multicaulis* cuts, and have now the finest trees of 4 inches in diameter. They are thickly covered with large leaves, many 6 by 8 inches, easy to gather and abundant.

No frost ever hurts them here, and, in conclusion, I believe that the *multicaulis* leaves are the best and most profitable of all mulberries, the healthiest for the worms, and produce the best cocoons and the finest quality of silk. * * * Being conversant with this industry, I am willing to give help and service to persons who wish to engage in this business.

Mr. H. T. Vose, Syracuse, Otoe County, Nebraska, reported, June 10, 1882, that the worms were doing finely and were then nearly ready to spin, having been fed on the Bois d'arc, or Osage orange. He says: "The silk made by the worms from this feed may have a special value for some fabrics."

E. H. Benedict, Marietta, Ohio, reported failure, and that the eggs were unreliable, June 12, 1882. Only about 150 eggs hatched, and the worms from these soon died, not being vigorous. These were of the Japanese race which we received and sent out without name, but which proved to be yellow. Mr. Benedict fed them on mulberry, and reports the temperature at which they were kept as 75°. Fortunately he has some eggs, raised by himself, which are of a choice variety, and which he wishes to sell.

Under date of June 2, 1882, Mr. John C. Andrus, of Manchester, Scott County, Illinois, sent samples of cocoons raised from eggs furnished by the Department, with the following report:

About three-fourths of the white and two-thirds of the yellow eggs hatched. None were lost in different molting periods; six went into the chrysalis stage without spinning. *They were all raised on Osage orange leaves.* A lady friend of some seventy-five years of age is reeling nicely the balance of the cocoons, after retaining quite a number for eggs.

This small experiment has satisfied me that we have the food going to waste in our State to raise all the silk needed in the United States; all that is needed is to bring this industry before the people when we have more surplus labor than at present. Still, I think quite a large amount of cocoons could be raised if a market could be obtained for them. * * * The ease of gathering the food from our miles of hedges is nothing in comparison to the labor of doing the same with the mulberry.

Mrs. Theodore H. Hittell, corresponding secretary of the California Silk-Growers' Association, writes, May 4, 1882:

We take pleasure in forwarding to you the first annual report of the California Silk Culture Association. We hope you will be gratified in seeing the progress we have made in our efforts to introduce home silk culture into our Golden State.

The idea upon which our efforts have been based originated with you. From the very start, acting upon your suggestions, we were satisfied that silk culture could be made a success amongst us, and that its success would be one of the greatest benefits that could be conferred upon our people. The example of France, for example, shows of what incalculable advantage it may, with judicious management, be made to the prosperity and welfare of a country. And we hope the time is not far distant when all the men of wealth and influence throughout the country and the goverment itself will recognize its importance and take the proper measures to make it one of our great national industries.

It seems to us that the future success of silk manufacture in the United States depends upon the home production of the raw material. In this view it is important to call attention to the formation of the mischief threatening the silk guild of Yokohama, which is described as follows:

"The Chinese and Japanese now have sufficient intercourse with the United States and Europe to avail themselves of any 'tricks of trade' which they are likely to learn from the astuter Caucasian portion of the human race, and to such tuition may largely be ascribed the formation of the Japanese silk guild.

"It is just possible that the not only non-resisting but acquiescent English silk-buyers of Yokohama may, for anything but worthy motives, be in league with the native silk brokers and merchants. To us at a distance it does seem passing strange that the guild should obtain any encouragement from a class for whose obvious advantage it is to keep the silk trade as open and unhampered as possible.

"On a consideration of the whole question, the restrictions sought to be imposed by the guild, the probability of the Chinese following the example of the Japanese by forming a similar obstructive guild at every port, it is evidently the duty of silk-consuming countries to aim at being independent as quickly as possible of China and Japan for raw material."

It is clear from the foregoing that it is of prime importance to the silk-manufacturing interest of the country to encourage home production; and that whatever aid in the way of protection that may be necessary to start American silk culture and put it on a firm basis is a matter of national concern. We are able with a little encouragement to become, and we ought to be, entirely independent of Japan and China. Every spot where the mulberry will grow and the silkworm thrive, from the Atlantic to the Pacific, from Canada to Mexico, should be availed of. It is daily becoming more expensive and inconvenient to import the raw material from Japan and China, and we find by almost every mail new accounts of additional obstacles being placed in the way of our manufacture in those countries. Under these circumstances is it not plain that the interest of the silk manufacturers throughout the country, and we may add of the country itself, are involved in our efforts to naturalize the production of the raw material? We ought to be aided in our start, because it is evident that the result will be of incalculable benefit. Every fiber of silk used in the United States can easily be and ought to be produced within the circuit of the United States.

The Yokohama Gazette, of November 24, says:

"The silk war has come to a most lame and 'impotent conclusion.' The establishment of a central silk warehouse has been agreed to; the foreign associations have virtually yielded almost everything, and the Rengo Kiito Niadzukarisko has secured all the advantages it was formed to obtain. Nominally the trade reverts, to some extent, to its original status, but in reality it stands on a very different footing. Silk buyers will find this out before they are many years older; in the mean time let them enjoy their dearly-bought treaty of peace as best they may. The Japanese have probably learned a lesson which hereafter they may perhaps be able to turn to account, which is that foreign determination, firmness of purpose, or whatever else it may be called, is not impregnable to all assaults. Continual dripping wears away a stone. The simile is an old one, but it holds good in this case. Japanese have only to stand out long enough and foreign opposition will melt away as surely as snow does in sunshine."

We have taken the liberty to call your attention to the above facts and consideration for the purpose of soliciting your further efforts in securing the establishment of American silk culture.

We beg that your influence may be exerted in preventing any legislation on the subject which may hamper the incipient industry, and in securing such legislation as may foster and *protect* it.

The manufacturers should be made to see that their interests are with the encouragement of our efforts. And in our endeavor to make this plain to them, and to enlist their sympathy and assistance in securing the object of our association, we ask the aid of your will and influence and a continuation of your powerful advocacy.

We should be glad to hear any suggestions you may have to make upon the subject of this communication or upon the subject of silk culture in general.

EXPERIENCE IN 1882 AT THE DEPARTMENT.

In this Division this year (1882) experiments were made upon several races of silk-worms.

A quantity of eggs which were sent us at two different times, loose in boxes, by the "Corinth (Miss.) Silk Company, L. S. Crozier, manager," as of the yellow race from Cevennes, were rapidly hatching when received, and although somewhat checked in their growth for a time were only saved by allowing the worms to begin feeding on lettuce leaves about the 1st of April. This food was continued for nearly two weeks before mulberry buds appeared. After that, for some time, the buds had to be hashed. Before good-sized leaves could be obtained most of the worms of this lot had died. Those which survived were so much retarded by the cool weather that they occupied about two months in getting their growth, and formed their cocoons about the end of May and first of June quite irregularly. This is a striking illustration of the influence of the food and temperature on the duration of insect life, and of the comparative worthlessness of isolated data or anything but averages in considering the subject. The cocoons formed by these worms were large, of a saffron yellow color. The moths were amongst the earliest to emerge, and such eggs as were not put away in a cool place began to hatch about a week after they were laid.

Another lot, received from the same parties, as of the black race, had a history essentially the same as that of the yellow race. The worms of this lot were about equally of two sorts, the one being indistinguishable throughout in appearance from the yellow race, and the other being darker colored. They also were fed on mulberry. Their cocoons did not differ from those of the yellow race. From the light variety of the worms about an equal number of the two sexes of the moths was obtained; from the dark variety nearly all were males.

A portion of the lot imported from Japan for distribution was retained, and divided into two parts, one of which was fed on Osage orange and the other on mulberry. These were of the sulphur-yellow variety. They also were too far advanced when received by us, owing to the exposure to which they had been subjected in transportation from Japan, but were not allowed to hatch until the third week in April. The worms fed on mulberry were more precocious than those fed on the Osage orange, and produced a large and good crop, but nearly all that were fed on Osage orange died after their last molt and just as they were presumed to be ready to make their cocoons.

Mr. E. Fasnach, of Raleigh, N. C., sent a very few eggs of a black breed from Thibet, which were not allowed to hatch until about the first of May, and were carefully fed on mulberry leaves. These worms, like the yellow French ones, presented two appearances, one portion being of the ordinary color but the others becoming ivory black after the second molt. The cocoons were also various, most of them being like those of the French breeds, but one or two being smaller and pure white. This experience would indicate that this black Thibet breed is made up of the darker or black individuals of various other breeds, and that there is a strong tendency to atavism or reversion to the normal pale coloring. It may be stated here that certain individuals of all races show a tendency to become dark, and thus revert to what were undoubtedly the ancestral colors of the species.

A lot of eggs received from Miss L. L. Buster, of Somerset, Pulaski County, Kentucky, was hatched for experiment, and the worms fed on Osage orange. When in their fourth stage some of them showed signs of disease, and the whole lot was removed to an attic, where it received irregular care. As the worms approached the spinning point they became covered with a fetid, green slime. They were removed immediately from their old trays and the trays cleared of filth, but although the slime dried away it left them discolored, and they died rapidly, decaying almost immediately. The first worms which began making cocoons died and rotted before their work was completed, and the others made no beginning. The race was evidently diseased.

We had worms from three of our own lots carried through their transformations. These were partly of a Japanese white race and partly of a Japanese yellow race, both of which we first fed on Osage orange in 1872, and have kept on the plant exclusively every year since. They both did well, the white race doing the better. We have been greatly interested to find that the yellow race, which in the beginning made cocoons of a bright sulphur-yellow color, have in the course of this feeding on Osage orange, come to make cocoons that are only yellowish-white, showing, so far as the color of the silk is concerned, a marked improvement over their progenitors; the cocoons, moreover, are fully equal, in texture and firmness, to either the white or the bright yellow. The white cocoons from the Osage orange were fully equal if not superior to the average of those from mulberry-fed worms.

NEW MULBERRY TREE.

Mr. Abram Thiessen, P. O. box 245, Fairbury, Nebr., issued an advertising circular in the fall of 1881, from which I make a few extracts.

He imported from the German colonies in Southern Russia what he calls the "Caucasian mulberry tree," which he says grows very well in the Western States of North America. In Jefferson County, Nebraska, he raised trees which became 8 inches in diameter and 16 feet high in six years:

The leaves of the tree are the best for raising silk cocoons which are of first quality. The silkworms do better here than they did in Southern Russia. * * *

On my father's farm, Colony Schœnau, in Southern Russia, there were trees of thirty years' growth which reached a height of 35 feet, and the trunks about 5 feet from the ground were 13 feet in circumference. * * *

Cuttings don't grow very well except with the greatest care. * * * The young trees should be started by seedlings, * * * from the 1st of October up to the middle of May. Spring planting is better than fall planting. * * *

The tree thrives in every soil, even in marsh land. Only in alkali soil the tree gets sick and dies. From Southern Dakota down to Texas the Caucasian mulberry has grown well everywhere.

BUSINESS VENTURES: SALE OF EGGS.

Several parties have undertaken business ventures in connection with the silk-producing industry. Foremost amongst these has been Mr. L. S. Crozier, of Corinth, Miss., already referred to, and who offered mulberry trees and silkworm eggs for sale, and offered to buy all the cocoons sent to him produced by worms raised on proper kinds of mulberry trees.

Abraham Thiessen, P. O. box 245, Fairbury, Nebr., offers 1,000 silk eggs for 25 cents; one ounce for $3; 1,000 mulberry seed for 25 cents. Will have mulberry seed to sell by the pound in the fall of 1882. He offers seedling mulberry trees from 4 inches high at 2 cents each and $10 per 1,000; 8 feet high at 35 cents each, $20 per hundred and $175 per thousand, delivered free of charge at the depot in Fairbury. He has reels, but does not offer to buy cocoons.

The Corinth (Miss.,) Silk Company, L. S. Crozier, manager, offers 1,000 eggs for $1, 1 ounce for $6; mulberry trees from one year old at $10 per hundred, two years old at $15 per hundred, and mulberry cuttings at $2 per hundred. It offers to pay cash at Lyons prices for all good cocoons received.

The Woman's Silk Culture Association of the United States, 1328 Chestnut street, Philadelphia, Pa., offers 1,000 eggs for $1, ½ ounce for

$3, 1 ounce for $5; lower in quantities. It has no mulberry seed or trees for sale. It has established a filature, and offers to pay for cocoons according to the market value of the silk obtained therefrom when reeled and prepared for manufacturing uses; also to receive and sell at the best market prices all silk waste that may be raised, including pierced cocoons, floss silk, and wild silk. A commission of 10 per cent. upon all sales will be charged by the association.

A "chart and instructions for silk growers," by W. C. Kerr, State geologist of North Carolina, can be obtained by applying to the association, inclosing 10 cents postage.

Messrs. McKittrick & Co., Second street, Memphis, Tenn., offer to pay "more than Lyons prices" for cocoons.

Messrs. Virion des Lauriers & Co., 201 East Sixty-third street, New York, imported and sold large quantities of eggs at reasonable prices.

SUMMARY OF THE SILK-GROWING QUESTION.

To meet the increasing demands for information, a second edition of our Manual (Special Report No. 11) has been issued, the preface of which we reproduce below as a summary of the present condition and prospects of the silk-producing industry in this country:

PREFACE TO THE SECOND EDITION.

That there exists just now a very general and widespread interest in the subject of silk culture in the United States is manifest from the recent large increase in the correspondence of the Entomological Division in relation thereto, and from the demand made for this Manual. To avoid the disappointment that is sure to follow exaggerated and visionary notions on the subject, it may be well here to emphasize the facts that the elements of successful silk culture on a large scale are at the present time entirely wanting in this country; that the profits of silk culture are always so small that extensive operations by organized bodies must prove unprofitable where capital finds so many more lucrative fields for employment; that extensive silk raising is fraught with dangers that do not beset less ambitious operations; that silk culture, in short, as shown in this Manual, is to be recommended only as a light and pleasant employment for those members of the farmer's household who either cannot do or are not engaged in otherwise remunerative work.

The want of experience is a serious obstacle to silk culture in this country; for while, as is shown in the following pages, the mere feeding of a certain number of worms and the preparation of the cocoons for market are simple enough operations, requiring neither physical strength nor special mental qualities, yet skill and experience count for much, and the best results cannot be attained without them. In Europe and Asia this experience is traditional and inherited, varying in different sections both as to methods and races of worm employed. With the great variety of soil, climate, and conditions prevailing in this country, experience in the same lines will also vary, but the general principles indicated in this Manual should govern.

The greater value of labor here as compared with labor in the older silk-growing countries has been in the past a most serious obstacle to silk culture in the United States, but conditions exist to-day that render this obstacle by no means insuperable. In the first place comparative prices, as so often quoted, are misleading. The girl who makes only twenty or thirty cents a day, in France or Italy, does as well, because of the relatively lower prices of all other commodities there, as she who earns three or four fold as much here. Again, the conditions of life are such in those countries that every woman among the agricultural classes, not absolutely necessary in the household, finds a profitable avenue for her labor in field or factory, so that the time given to silk-raising must be deducted from other profitable work in which she may be employed. With us, on the contrary, there are thousands—aye, hundreds of thousands—of women who, from our very conditions of life, are unable to labor in the field or factory, and have, in short, no means, outside of household duties, of converting labor into capital. The time that such might give to silk culture would, therefore, be pure gain, and in this sense the cheap-labor argument loses nearly all its force. This holds more particularly true in the larger portion of the South and West that are least adapted to the production of merchantable dairy products or where bee-keeping and poultry-raising are usually confined to the immediate wants of the household.

The want of a ready market for the cocoons is now, as it always has been, the most serious obstacle to be overcome, and the one to which all interested in establishing silk culture should first direct their attention. Ignore this, and efforts to establish the industry are bound to fail, as they have failed in the past. A permanent market once established, and the other obstacles indicated will slowly, but surely, vanish as snow before the coming spring. Owing to the prevalence of disease in Europe, there grew up a considerable demand for silkworm eggs in this country, so that several persons found the production of these eggs quite profitable. Large quantities are yet shipped across the continent from Japan each winter; but this demand is, in its nature, transient and limited, and with the improved Pasteur method of selection, and prevention of disease, silk-raisers are again producing their own eggs in Europe. Silk culture must depend for its growth, therefore, on the production of cocoons, and these will find no remunerative sale except where the silk can be reeled. I find no reason to change the views expressed relative to the part this Department might take in succoring silk culture through Congressional aid; for, however just and desirable direct protection to the industry may be by the imposition of an import duty on reeled silk, no such protection has yet been given by Congress, and silk filatures cannot be fully and profitably established without some fostering at the start. Under a heavy protective tariff our silk manufactures have rapidly grown in importance and wealth, until, during the year 1881 (according to the reports of W. C. Wyckoff, secretary of the Silk Association of America), raw silk to the value of $11,936,865, and waste silk and cocoons to the value of $769,186 were imported at the ports of New York and San Francisco, while our manufactured goods reached in value between $35,000,000 and $40,000,000. Now, the so-called raw silk thus imported to the value of nearly $12,000,000, is just as much a manufactured article as the woven goods, and its importation free of duty is as much an encouragement to foreign manufacturers and an impediment to home industry as the removal of the duty would be on the woven goods. The aid that Congress, through this Department, should, in my judgment, give to silk-reeling, and thereby to silk-production, may be supplied by private and benevolent means; and I am pleased to record, in this connection, the recent efforts of the Women's Silk Culture Association of California and the similar association in Philadelphia. This last organization has in operation a good hand-reel, worked by a skilled Italian, and the secretary, Mrs. John Lucas, offers to purchase cocoons at prices ranging from $1 to $1.50 per pound, according to quality. Messrs. Crozier & Co., of Corinth, Miss., and Messrs. McKittrick & Co., of Memphis, Tenn., also advertise that they will purchase cocoons at Lyons prices. These are beginnings in the right direction, but so far the efforts are warranted only in the former case through benevolent support, and in the latter as an aid to a general business of supplying eggs and mulberry trees.

The obstacles which I have set forth are none of them permanent or insuperable, while we have some advantages not possessed by other countries. One of infinite importance is the inexhaustible supply of Osage orange (*Maclura aurantiaca*) which our thousands of miles of hedges furnish; another is the greater average intelligence and ingenuity of our people, who will not be content to tread merely in the ways of the Old World, but will be quick to improve on their methods; still another may be found in the more spacious and commodious of the farmers' barns and outhouses. Every year's experience with the *Maclura* confirms all that I have said of its value as silkworm food. Silk which I have had reeled from a race of worms fed on it, now for eleven consecutive years, is of the very best quality, while the tests made at the recent silk fair at Philadelphia showed that in some instances a less weight of cocoons spun by *Maclura*-fed worms was required for a pound of reeled silk than of cocoons from mulberry-fed worms.

C. V. R.

WASHINGTON, D. C., *February* 20, 1882.

From the tenor of the correspondence of the Division, and from the constantly increasing interest manifested in the subject since the above was written, we feel constrained to add a few other words of caution, more particularly, since, in obedience to the large demands for eggs, the Department has been urged to make very large purchases of these for distribution. Under present circumstances we feel more disposed to check than to encourage the present growing interest in the subject, because of the conviction that the majority of persons undertaking the raising of silkworms are doomed to disappointment. Those who have eggs for sale or who are interested in the propagation and sale of mulberry cuttings, and those who are influenced by philanthropic or benevolent motives, can afford, albeit from opposite motives, to stimulate in every possible way the interest naturally felt in the subject, but the disappointment, under existing circumstances, is apt to be great in proportion as the interest increases, so that there is danger of a repetition of the many reactions from similar attempts in the past.

This follows necessarily from the fact that the reeled silk is imported free of duty, while there is so very heavy a duty on the woven goods. There is a duty to-day on wools valued at 32 cents of 10 to 11 cents per pound, and 10 per cent. ad valorem. Still, in past years, as in 1846, wool has been imported free of duty. Now wool is essentially a raw product, having gone through no expensive process of manufacture; yet what would our wool-growers throughout the country say if it were proposed to do away with the duty and allow wool to come in as reeled silk is now allowed to come in, free? They would, no doubt, declare that such action on the part of Congress would give the death-blow to wool-growing in the United States. Silk culture is in just the condition that wool-growing would be in under such circumstances, and if there is any advantage to the country in the protection of one kind of silk-manufacture, then, logically, that other branch of silk-manufacture, namely, silk-reeling, which would add value to the coccoon and give encouragement to its production, should also be protected, and we earnestly recommend this subject to the serious consideration of the recently-appointed Tariff Commission. With proper duty on the "raw silk," there would be no question of the steady and permanent growth of the silk culture in the United States; this Department would be justified in making efforts to widely disseminate the eggs, and in the course of two or three years every dollar of the vast sums sent out of the country for "raw silk" produced in foreign lands would find its way to the pockets of our own people.

PYRETHRUM: ITS USE AS AN INSECTICIDE.

[Plates III, IV.]

A large quantity of Pyrethrum seed has been distributed to correspondents. The seed was obtained either direct from parts of Russia and the Caucasus or from Trieste, Austria. The packages were accompanied by the following:

CIRCULAR IN REFERENCE TO PYRETHRUM:

DEPARTMENT OF AGRICULTURE, *Washington, D. C.*

SIR: In the spring of 1881 Prof. C. V. Riley, on behalf of the United States Entomological Commission, distributed the seed of *Pyrethrum roseum* and *Pyrethrum cinerariæfolium* to a number of correspondents in different parts of the country, and while the excessive drought rendered the experiments in growing it in many cases unsuccessful, yet the reports are sufficiently favorable to warrant further trial.

The value of these plants in furnishing a perfectly effectual insecticide, that can be used against many of the worst insects injurious to our crops as well as against household and greenhouse pests, without danger to man or beast, has been fully established by experiments made under his direction during the past two years. The general cultivation of the plants in all sections where they will succeed is, therefore, most desirable. A small package of seed, duly labeled, is sent to you from this Department for trial, and the following statement regarding the nature, cultivation, and use of these plants, prepared by the entomologist of the Department,* is sent to guide you in such trial. I shall be glad to have you report to the Department the result of your experiment, and to aid in any other way within my power toward its success.

Respectfully,

GEO. B. LORING,
Commissioner of Agriculture.

HISTORY OF PYRETHRUM.

There are very few data at hand concerning the discovery of the insecticide properties of Pyrethrum. The powder has been in use for many years in Asiatic countries south of the Caucasus Mountains. It was sold at a high price by the inhabitants, who successfully kept its nature a secret until the beginning of this century, when an Armenian merchant, Mr. Jumtikoff, learned that the powder was obtained from the dried and pulverized flower-heads of certain species of Pyrethrum growing abundantly in the mountain region of what is now known as the Russian province of Transcaucasia. The son of Mr. Jumtikoff began the manufacture of the article on a large scale in 1828, after which year the Pyrethrum industry steadily grew, until to-day the export of the dried flower-heads represents an important item in the revenue of those countries.

Still less seems to be known of the discovery and history of the Dalmatian species of Pyrethrum (*Pyrethrum cinerariæfolium*), but it is probable that its history is very similar to that of the Asiatic species. At the present time the Pyrethrum flowers are considered by far the most valuable products of the soil of Dalmatia.

There is also very little information published regarding either the mode of growth or the cultivation of Pyrethrum plants in their native home. As to the Caucasian species we have reason to believe that they are not cultivated, at least not at the present time, statements to the contrary notwithstanding.† The well-known Dr. Gustav Radde, director of the Imperial Museum of Natural History at Tiflis, Transcaucasia, who is the highest living authority on everything pertaining to the natural history of that region, wrote us recently as follows: "The only species of its genus, *Pyrethrum roseum*, which gives a good, effective insect powder, is nowhere cultivated, but grows wild in the basal-alpine zone of our mountains at an altitude of from 6,000 to 8,000 feet." From this it appears that this species, at least, is not cultivated in its native home, and Dr. Radde's statement is corroborated by a communication of Mr. S. M. Hutton, vice-consul-general of the United States at Moscow, Russia, to whom we applied for seed of this species. He writes that his agents were not able to get more than about half a pound of the seed from any one person. From this statement it may be inferred that the seeds have to be gathered from the wild and not from the cultivated plants.

As to the Dalmatian plant it is also said to be cultivated in its native home, but we can get no definite information on this score, owing to the fact that the inhabitants are very unwilling to give any information regarding a plant the product of which they wish to monopolize. For similar reasons we have found great difficulty in obtaining even small quantities of the seed of *P. cinerariæfolium* that was not baked or in other ways tampered with to prevent germination. Indeed the people are so jealous of their plant that to send the seed out of the country becomes a serious matter, in which life is risked.

The seed of *Pyrethrum roseum* is obtained with less difficulty, at least in small quantities, and it has even become an article of commerce, several nurserymen here, as well as in Europe, advertising it in their catalogues. The species has been successfully grown as a garden plant for its pale rose or bright pink flower-rays. Mr. Thomas Meehan, of Germantown, Pa., writes us: "I have had a plant of *Pyrethrum roseum* in my herbaceous garden for many years past, and it holds its own without any care much better than many other things. I should say from this experience that it was a plant which will very easily accommodate itself to culture anywhere in the United States." Peter Henderson, of New York, another well-known and experienced nurseryman, writes: "I have grown the plant and its varieties for ten years. It is of the easiest cultivation, either by seeds or divisions. It now ramifies into a great variety of all shades, from white to deep crimson, double and single, perfectly hardy here, and I think likely to be nearly everywhere on this continent." Dr. James C. Neal, of Archer, Fla., has also successfully grown *Pyrethrum roseum* and many varieties thereof, and other correspondents report similar favorable experience. None of them have found a special mode of cultivation necessary. In 1856 Mr. C. Willemot made a serious at-

*From recent communications by him to the *American Naturalist*.
†Report Comm. of Patents, 1857, Agriculture, p. 130.

tempt to introduce and cultivate the plant* on a large scale in France. As his account of the cultivation of Pyrethrum is the best we know of, we quote here his experience, with but few slight omissions: "The soil best adapted to its culture should be composed of a pure ground, somewhat siliceous and dry. Moisture and the presence of clay is injurious, the plant being extremely sensitive to an excess of water, and would in such case immediately perish. A southern exposure is the most favorable. The best time for putting the seeds in the ground is from March to April. It can be done even in the month of February if the weather will permit it. After the soil has been prepared and the seeds are sown they are covered by a stratum of ground mixed with some vegetable mold, when the roller is slightly applied to it. Every five or six days the watering is to be renewed in order to facilitate the germination. At the end of about thirty or forty days the young plants make their appearance, and as soon as they have gained strength enough they are transplanted at a distance of about 6 inches from each other. Three months after this operation they are transplanted again at a distance of from 14 to 20 inches, according to their strength. Each transplantation requires, of course, a new watering, which, however, should only be moderately applied. The blossoming of the Pyrethrum commences the second year toward the end of May, and continues to the end of September." Mr. Willemot also states that the plant is but slightly sensitive to cold, and needs no shelter even during severe winters.

The above-quoted directions have reference to the climate of France, and as the cultivation of the plant in many parts of North America is yet an experiment, a great deal of independent judgment must be used. The plants should be treated in the same manner as the ordinary Asters of the garden or other perennial Compositæ.

As to the Dalmatian plant, it is well known that Mr. G. N. Milco, a native of Dalmatia, has of late years successfully cultivated *Pyrethrum cinerariæfolium* near Stockton, Cal., and the powder from the California-grown plants, to which Mr. Milco has given the name of "Buhach," retains all the insecticide qualities, and is far superior to most of the imported powder, as we know from experience. Mr. Milco gives the following advice about planting, advice which applies more particularly to the Pacific coast: "Prepare a small bed of fine, loose, sandy, loamy soil, slightly mixed with fine manure. Mix the seed with dry sand and sow carefully on top of the bed. Then with a common rake disturb the surface of the ground half an inch in depth. Sprinkle the bed every evening until sprouted; too much water will cause injury. After it is well sprouted watering twice a week is sufficient. When about a month old weed carefully. They should be transplanted to loamy soil during the rainy season of winter or spring."

Our own experience with *Pyrethrum roseum* as well as *Pyrethrum cinerariæfolium* in Washington, D. C., has been so far quite satisfactory. Some that we planted in the fall of 1880 came up quite well in the spring, and a few plants bloomed in November of 1881, though such blooming was doubtless abnormal. The plants from sound seed which we planted this spring are also doing finely, and as the soil is rather a stiff clay and the rains were in early summer many and heavy, we conclude that Mr. Willemot has overstated the delicacy of the plants. We have observed further that the seed often lays a long time in the ground before germinating, and that it germinates best when not watered too heavily. We think that the too rapid absorption of moisture often causes the seed to burst prematurely and rot, where slower absorption in a soil only tolerably moist affords the best conditions for germination.

PREPARATION OF THE PLANTS FOR USE.

In regard to manufacturing the powder, the flower-heads should be gathered during fine weather, when they are about to open, or at the time when fertilization takes place, as the essential oil that gives the insecticide qualities reaches, at this time, its greatest development. When the blossoming has ceased the stalks may be cut within about four inches from the ground and utilized, being ground and mixed with the flowers in the proportion of one-third of their weight. Great care must be taken not to expose the flowers to moisture, or the rays of the sun, or still less to artificial heat. They should be dried under cover and hermetically closed up in sacks or other vessels to prevent untimely pulverization. The finer the flower-heads are pulverized the more effectually the powder acts and the more economical is its use. Proper pulverization in large quantities is best done by those who make a business of it and have special mill facilities. Lehn & Fink, of New York, have furnished us with the most satisfactory powder. For his own use the farmer can pulverize smaller

*Mr. Willemot calls his plant *Pyrèthre du caucase* (*Pyrethrum Willemoti* Duchartre), but it is more than probable that this is only a synonym of *Pyrethrum roseum*. We draw liberally from Willemot's paper on the subject, a translation of which may be found in the Report of the Commissioner of Patents for the year 1861, Agriculture, pp. 323-331.

quantities by the simple method of pounding the flowers in a mortar. It is necessary that the mortar be closed, and a piece of leather through which the pestle moves, such as is generally used in pulverizing pharmaceutic substances in a laboratory, will answer. The quantity to be pulverized should not exceed one pound at a time, thus avoiding too high a degree of heat, which would be injurious to the quality of the powder. The pulverization being deemed sufficient, the substance is sifted through a silk sieve, and then the remainder, with a new addition of flowers, is put in the mortar and pulverized again.

The best vessels for keeping the powder are fruit jars with patent covers, or any other perfectly tight glass vessel or tin box.

Up to a comparatively recent period the powder was applied to the destruction of those insects only which are troublesome in dwellings, and Mr. C. Willemot seems to have been the first, in the year 1857 (?), to point out its value against insects injurious to agriculture and horticulture. He goes, however, too far in his praise of it, and some of his statements as to its efficacy are evidently not based upon actual experiment. Among others he proposes the following remedy: "In order to prevent the ravages of the weevil on wheat fields, the powder is mixed with the grain to be sown, in proportion of about ten ounces to about three bushels, which will save a year's crop." This is simply ridiculous, as every one who is familiar with the properties of Pyrethrum will understand. We have during the past three years largely experimented with it on many species of injurious insects, and fully appreciate its value as a general insecticide, which value has been greatly enhanced by the discovery that it can be most economically used in liquid solution; but we are far from considering it a universal remedy for all insects. No such universal remedy exists, and Pyrethrum has its disadvantages as has any other insecticide now in use. The following are its most serious disadvantages: 1, the action of the powder, in whatever form it may be applied, is not a permanent one in the open air. If, *e. g.*, it is applied to a plant, it immediately affects the insects on that plant with which it comes in contact, but it will prove perfectly harmless to all insects which come on to the plant half an hour (or even less) after the application; 2, the powder acts in the open air—unless, perhaps, applied in very large quantities—only upon actual contact with the insect; if, *e. g.*, it is applied to the upper side of a cotton leaf the worms that may be on the underside are not affected by it; 3, it has no effect on insect eggs, nor on pupæ that are in any way protected or hardened.

These disadvantages render Pyrethrum in some respects inferior to arsenical poisons, but, on the other hand, it has the one overshadowing advantage that it is perfectly harmless to plants or to higher animals; and if the cultivation of the plants in this country should prove a success, and the price of the powder become low enough, the above-mentioned disadvantages can be overcome, to a certain degree, by repeated applications.

In a closed room the effect of Pyrethrum on insects is more powerful than outdoors. Different species of insects are differently affected by the powder. Some resist its action most effectually, *e. g.*, very hairy caterpillars, and especially spiders of all kinds; while others, especially all Hymenoptera, succumb most readily. In no case are the insects killed instantaneously by Pyrethrum. They are rendered perfectly helpless a few minutes after application, but do not die till some time afterward, the period varying from several hours to two or even three days, according to the species. Many insects that have been treated with Pyrethrum show signs of intense pain, while in others the outward symptoms are much less marked. Differences in temperature and other meteorological changes do not appear to have any influence on the effect of Pyrethrum.

MODES OF APPLICATION.

Pyrethrum can be applied—1, as dry powder; 2, as a fume; 3, as an alcoholic extract diluted; 4, by simple stirring of the powder in water; 5, as a tea or decoction.

The following recommendations are based on repeated experiments in the field:

1. *Application of Pyrethrum as dry powder.*—This method is familiar to most housekeepers, the powder being used by means of a small pair of bellows. It is then generally used without diluent, but if it is unadulterated and fresh (which cannot be said, in many instances, of the powder sold at retail by our druggists) it may be considerably diluted with other pulverized material without losing its deadly effect, the use of the powder thus becoming much cheaper. Of the materials which can be used as diluents common flour seems to be the best, but finely-sifted wood-ashes, sawdust from hard wood, &c.—in short, any light and finely-pulverized material which mixes well with the Pyrethrum powder will answer the purpose. If the mixture is applied immediately after preparation it is always less efficacious than when left in a perfectly tight vessel for about 24 hours, or longer, before use. This has been proven so far only with the mixture of Pyrethrum with flour, but holds doubtless true also for other diluents. Mr. E. A. Schwarz experimented largely under our direction with the mixture of Pyrethrum and flour for the cotton worm, and he found that one part of the

powder to 11 parts of flour is sufficient to kill the worms (only a portion of the full-grown worms recovering from the effects of the powder), if the mixture is applied immediately after preparation; but if kept in a tight glass jar for about two days, one part of the powder to 22 parts of flour is sufficient to kill all average-sized worms with which the mixture comes in contact. For very young cotton worms a mixture of one part of Pyrethrum to 30 parts of flour, and applied one day after preparation, proved most effective, hardly any of the worms recovering.

An ordinary powder bellows will answer for insects infesting dwellings or for plants kept in pots in rooms, or single plants in the garden, but it hardly answers on a large scale outdoors, because it works too slowly; the amount of powder discharged cannot be regulated, and there is difficulty in covering all parts of a large plant. Another method of applying the dry powder is to sieve it on to the plants by means of sieves, and this method is no doubt excellent for insects that live on the upper side of the leaves. For large, more shrub-like plants with many branches, and for insects that hide on the underside of the leaves, this method will be found less serviceable. A very satisfactory way of applying the powder on large plants, in the absence of any suitable machine or contrivance, is to throw it with the hand after the manner of seed-sowing. This method is more economical and rapid than those mentioned above, and it has, moreover, the advantage that, if the plants are high enough, the powder can be applied to the underside of the leaves.

2. *Application of Pyrethrum in fumes.*—The powder burns freely, giving off considerable smoke and an odor which is not unpleasant. It will burn more slowly when made into cones by wetting and molding. In a closed room the fumes from a small quantity will soon kill or render inactive ordinary flies and mosquitoes, and will be found a most convenient protection against these last where no bars are available. A series of experiments made under our direction indicates that the fumes affect all insects, but most quickly those of soft and delicate structure.

This method is impracticable on a large scale in the field, but will be found very effective against insects infesting furs, feathers, herbaria, books, &c. Such can easily be got rid of by inclosing the infested objects in a tight box or case and then fumigating them. This method will also prove useful in greenhouses, and, with suitable instruments, we see no reason why it should not be applied to underground pests that attack the roots of plants.

3. *Alcoholic extract of Pyrethrum powder.*—The extract is easily obtained by taking a flask fitted with a cork and a long and vertical glass tube. Into this flask the alcohol and Pyrethrum are introduced and heated over a steam tank or other moderate heat. The distillate, condensing in the vertical tube, runs back, and at the end of an hour or two the alcohol may be drained off and the extract is ready for use. Another method of obtaining the extract is by repercolation after the manner prescribed in the American Pharmacopœia. The former method seems to more thoroughly extract the oil than the latter; at least we found that the residuum of a quantity of Pyrethrum from which the extract was obtained by repercolation had not lost a great deal of its power. The first method is apparently more expensive than the other, but the extract is in either case more expensive than the other preparations, though very conveniently preserved and handled.

The extract may be greatly diluted with water and then applied by means of any atomizer. Prof. E. A. Smith, of Tuscaloosa, Ala., found that, diluted with water at the rate of 1 part of the extract to 15 of water and sprayed on the leaves, it kills cotton worms that have come in contact with the solution in a few minutes. The mixture in the proportion of 1 part of the extract to 20 parts of water was equally efficacious, and even at the rate of 1 to 40 it killed two-thirds of the worms upon which it was sprayed in 15 or 20 minutes, and the remainder were subsequently disabled. In still weaker solution, or at the rate of 1 to 50, it loses in efficacy, but still kills some of the worms and disables others. Professor Smith experimented with the extract obtained by distillation, and another series of experiments with the same method was carried on last year by Prof. R. W. Jones, of Oxford, Miss.* He diluted his extract with twenty times its volume of water, and applied it by means of an atomizer on the cotton worm and the boll worm with perfect success. Mr. E. A. Schwarz tried, last summer, the extract obtained by repercolation,† and found that 10 drachms of the extract stirred up in 2 gallons of water, and applied by means of Whitman's fountain-pump was sufficient to kill all cotton worms on the plants. Four drachms of the extract to the same amount of water was sufficient to kill the very young worms.

4. *Pyrethrum in simple water solution.*—So far as our experiments go, this method is by far the simplest, most economical, and efficient. The bulk of the powder is most easily dissolved in water, to which it at once imparts the insecticide power. No constant

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* Vide *American Entomologist*, Vol. III, pp. 252–3.

† From one pound of the powder one pint of extract was made, each drop of the extract representing one grain of the powder. The actual cost of making the extract was 50 cents.

stirring is necessary, and the liquid is to be applied in the same manner as the diluted extract. The finer the spray in which the fluid is applied the more economical is its use, and the greater the chance of reaching every insect on the plant. Experiments with Pyrethrum in this form show that 200 grains of the powder stirred up in 2 gallons of water is amply sufficient to kill the cotton worms, except a very few full-grown ones, but that the same mixture is not sufficiently strong for many other insects, as the boll worm, the larva of the *Terias nicippe*, and such species as are protected by dense long hairs. Young cotton worms can be killed by 25 grains of the powder stirred up in 2 quarts of water.

The Pyrethrum water is most efficacious when first made, and loses power the longer it is kept. The powder gives the water a light greenish color, which, after several hours, changes to a light brown. On the third day a luxuriant growth of fungus generally develops in the vessel containing the liquid, and its efficacy is then considerably lessened.

5. *The tea or decoction.*—Prof. E. W. Hilgard, of Berkeley, Cal., is the only one who has experimented with Pyrethrum in this form, and expresses himself most favorably as to the result. He says:

"I think, from my experiments, that the *tea or infusion prepared from the flowers* (which need not be ground up for the purpose) is the most convenient and efficacious form of using this insecticide in the open air; provided that it is *used at times when the water will not evaporate too rapidly*, and that it is applied, not by pouring over in a stream, or even in drops, but *in the form of a spray from a syringe* with *fine* holes in its nose. In this case the fluid will reach the insect despite of its water-shedding surfaces, hairs, &c., and stay long enough to kill. Thus applied, I have found it to be efficient even against the armored scale-bug of the orange and lemon, which falls off in the course of two or three days after the application, while the young brood is almost instantly destroyed. As the flower-tea, unlike whale soap and other washes, leaves the leaves perfectly clean and does not injure even the most tender growth, it is preferable on that score alone; and in the future it can hardly fail also to be the cheaper of the two. This is the more likely, as the tea made of the leaves and stems has similar although considerably weaker effects; and if the farmer or fruit-grower were to grow the plants, he would save all the expense of harvesting and grinding the flower-heads by simply using the header, curing the upper stems, leaves, and flower-heads altogether, as he would hops, making the tea of this material by the hogshead, and distributing it from a cart through a syringe. It should be diligently kept in mind that the least amount of *boiling* will seriously injure the strength of this tea, which should be *made* with briskly boiling water, but then simply covered over closely, so as to allow of as little evaporation as possible. The details of its most economical and effectual use on the large scale remains, of course, to be worked out by practice."

The method of applying Pyrethrum in either of the three last-mentioned forms is evidently far more economical in the open field and on a large scale than the application of the dry powder, and, moreover, gives us more chance of reaching every insect living upon the plant to which the fluid is applied. The relative merits of the three methods can be established only by future experience, but so far we have found the simple water solution most convenient and satisfactory.

EXPERIENCE WITH PYRETHRUM.

We shall not get definite reports from this distribution till next year, but the following extracts from reports of experience with some which we distributed in the winter and spring of 1881, and taken without selection, will indicate the varied experience last year, under the most unfavorable conditions, of an exceptionally severe drought. While most of the failures may fairly be attributed to this drought, many are doubtless due to bad seed and to the other difficulties of germination mentioned in the circular.

MISSISSIPPI. Canton, August 5, 1881.—T. G. Smith-Vaniz.

Failure this season. I watered continually, transferring part of the plants to shade, but the excessively hot weather, long continued, was too much for them.

IOWA. Sac County, Grant City, September 17, 1881.—Edwin Miller.

Of the seeds planted May 16 not one germinated.

ILLINOIS. Jo Daviess County.—[Friend of Edwin Miller above, September 17, 1881.]

Of the seeds planted not one germinated.

DAKOTA. Mapleton, September 17, 1881.—H. M. Williams.

Seeds did not germinate.

ILLINOIS. Rockford, September 18, 1881.—A. B. Willoughby.

Sowed *roseum* seeds in a bed of sand and dirt. A dry spell came on, and although I watered the bed no plants appeared. Perhaps I sowed them too early.

NEW JERSEY. Morris County, Chatham.—October 17, 1881.—James J. Dean.

Seed came up nicely in a garden. Plants flourished for a while, but as the season advanced they succumbed to the severe drought and perished before arriving at maturity.

NORTH CAROLINA. Goldsborough, October 22, 1881.—John Robinson.

But ten plants of *roseum* survived the heat of our excessively hot summer, and of these one-half are weakly.

MICHIGAN. Cadillac, October 24, 1881.—G. Wallace.

Some I sowed early in boxes never germinated; others late in May with like success; some I gave to a neighbor did not grow. Sowed the remainder in the first week in June in new forest land after being burned over; a few came up and seemed to be doing well; they were destroyed by accident.

GEORGIA. Spring Place, November 1, 1881.—William J. Johnson.

Seed sown came up very well and grew finely, while I gave them the attention they needed. Compelled to neglect them about the middle of July; they all died.

ALABAMA. Monroe County, Dennard, October, 1881.—Oliver Taylor.

The heated term coming on so soon after I sowed the seed I did not save but a few plants. I find the dust such a blessing I wish to raise a good lot.

MISSOURI. Cameron, November 11, 1881.—John Zimmerman.

The Pyrethrum did not do any good this season. The extreme drought stunted and stopped its growth so much that it did not recover when the rains did come.

NEW HAMPSHIRE. East Barrington, December 1, 1881.—William B. Swain.

Seeds of *roseum* sown on high loamy soil grew nicely and blossomed in September. The hard frost of October 3 stopped the blossoming. I have used the Dalmatian insect powder for almost all kinds of insects without a failure.

KENTUCKY. Louisville, December 18, 1881.—Samuel J. Thompson.

Roseum did not do well out in the ground; died of heat and drought. I have about two dozen plants in pots in the greenhouse.

INDIANA. Jay County, Dunkirk, December 20, 1881.—D. B. Moore.

Planted *roseum* in the garden in mellow clay loam; sowed the 1st of May; it failed to grow; condition of ground good; weather rather dry.

NEW YORK. Union Springs, January 6, 1882.—J. J. Thomas.

Sowed in different places in limestone and clay land. I suppose my soil was too strong and rich. I had none which was unmanured. The seed germinated and the plants grew a few inches, then ceased to grow and finally died. Those in the hot-bed did best, but did not reach over three or four inches. None flowered.

GEORGIA. Savannah, January 19, 1882.—A. Oemler.

My experiment with the Pyrethrum on Cut-worms was made in captivity in a match-box without soil, so that they could not rub it off. They were covered with the dust for twelve hours, while others ate leaves on the surface of which it had been sprinkled, without detriment. Larvæ of *Plusia brassicæ* and *Plutella cruciferarum* were killed.

ILLINOIS. Champaign, January 28, 1882.—B. F. Johnson.

Last season I could not, neither could a very skillful person in such matters, get a single seed to germinate.

NEW YORK. Suffolk County, January 31, 1882.—Zophar Mills, jr.

Last spring I planted half in a hot-bed about 15th April and half a little later in the open ground. Half of the sown seeds germinated, but the hot-bed plants did not succeed as well as those out of doors. In June the hot-bed plants were transplanted to my garden, the weather being warm. Both plants did as well as could be expected, but the out-of-door ones seemed to be most thrifty. I consider the plant quite hardy from last year's experiments. In August we had dry weather, and the plants suffered from want of attention. They gave no indication of blossoming September 28, when I last saw them.

ILLINOIS. Scott County, Manchester, January 1882.—J. C. Andrus.

From seeds of *roseum* received in spring of 1881 I have some 500 good plants growing now, or in good condition to start in the spring.

NEW YORK. Dutchess County, Pine Plains, January 28, 1882.—J. Walter Righter.

Planted *roseum* seed 10th May in light, sandy loam, and raised some very strong and healthy plants, but they produced only a very few flowers. I also planted in hot-bed and got a few plants of a very inferior quality. And, further, I sowed in the forest, where it was slightly shaded, and wasted my seed. (The soil all limestone.) Have protected the plants from exposure by throwing some cornstalks on them. Although the thermometer has marked 25° below zero here, the *P. roseum* looks as green as in midsummer.

KANSAS. Osborn County, Kill Creek, January 30, 1882.—J. J. Guyer.

Planted a part of the *roseum* seed last spring on sandy loam. Only a few of the seeds germinated, and owing to the hard summer we had they did not make any growth. All kinds of garden plants were a total failure here.

GEORGIA. Liberty County, Dorchester, February 4, 1882.—James A. M. King.

Divided seeds with four painstaking parties, and can report vigorous growth in sandy loam. The fearful hurricane of August 27 and 28 destroyed some plants, but those left measure now 16 by 18 inches spread, and will bloom early this spring.

MARYLAND. Washington County, Smithburg, February 4, 1882.—Benton Scholl.

The seeds of *roseum* received last spring were sown in well-prepared soil, of a rather heavy nature, as soon as the ground was in good working order. Very little of it vegetated, and that did the best which was the most shaded, as that which was the most exposed to the sun nearly all perished during the severest drought ever known in this locality. What survived did well enough until the cold snap of 22d January. I then covered the plants with litter, but when the ground opened I found that the plants were thrown out by the frost, and but two were yet alive. I then (a week ago) planted them in a pot and brought them into the sitting-room; they have now started finely.

ALABAMA. Selma, February 6, 1882.—John D. Wilkins.

Planted two lots last season, and failed to even get the seed to sprout.

MICHIGAN. Saginaw City, February 7, 1882.—Leopold Trakat.

During last summer only about 30 plants came up and survived. I watered them too freely and made some other blunders.

ONTARIO. Toronto.—Alfred Henry Moore.

Pyrethrum roseum would seem to bear the cold of Toronto by shelter in a depression covered by loose garden refuse. Some plants of same seed I distributed to others have not prospered, by want of care.

VERMONT. Brattleborough, February 8, 1882.—Abner L. Butterfield.

I planted the seed as soon as the ground was all right, but there was a heavy rain the next day, and it rained every day for a week, and then it was rather cold for the time of year, and the ground baked down so hard that only a few of the seed came up at all, and those that came up made very weak plants. I had but one blossom. One plant which I have at the kitchen window appears to be doing well.

CALIFORNIA. San Francisco, February 10, 1882.—Ed. Wolleb.

My place lies in Alameda County, on the hills overlooking the bay of San Francisco, in the so-called warm belt, 600 feet above sea-level. Three years ago I sowed seeds of *P. roseum* and had it in bloom last season. The plants do well—light loam, little irrigation. Last year I received from Germany seed of *P. cinerariæfolium*, and have now thousands of plants. * * * Planted *P. roseum* among roses, to protect the roses from *Diabrotica*, but it had no effect. I put some open flowers under a glass with some flies, but they produced no effect in 48 hours.

VIRGINIA. Norfolk County, Berkeley, February 12, 1882.—William R. Wood.

But two of last season's plants survived in my hands, and, as far as heard from, none of those sent to my correspondents. A slug which ate my plants was not injured by the meal.

NEW HAMPSHIRE. Goffstown Centre, February 13, 1882.—C. B. Moore.

Sowed the seed about first of June. Owing to cold weather through the month of June it did not come up very well. After it got started it grew finely. It failed to blossom before winter. I covered it upon approach of cold weather.

PENNSYLVANIA. Johnstown, February 22, 1882.—Frederick Brehm.

On April 18, 1881, I sowed some of the seed in a hot-bed, but received no plants, which I think was the fault of my watering too much. April 25 I sowed some of the seeds in two pots and placed them in a hot-bed. From this I received several plants. May 4 I again sowed some seeds in two pots and placed them in a hot-bed. From these I also received several plants. On May 11 I sowed some of the seeds in an open field. This proved much better than in hot-beds. The soil was light and the plants good.. The plants I watered from two to three times a week. On June 1 I transplanted the first plants; in September I had three flowers. I have in all fifty nice plants. The three flowers were not very good.

MISSISSIPPI. Canton, February 25, 1882.—George W. Smith-Vaniz.

I have plants started under glass, but I must say that last year's trial leads me to think there is not much chance here for its success.

OHIO. Glendale, March 3, 1882.—George W. Trowbridge.

About the 1st of March, 1881, a portion of the *P. roseum* seed was sown in a box and placed in a window of the living-room on the sunny side of the house, where in due time (though rather slow) they germinated. When all danger of severe frost was passed the box was placed out of doors, in a sunny exposure, where the plants remained until about May 1, when they were pricked out and set in the open ground. The remainder of the seed was sowed at two different times, March 20 and April 5, in the open ground, which had been prepared for the purpose and where they were permanently to stand and grow. Soil is rather a heavy clay. Seeds rather slow and long in germinating. The usual amount of hoeing and weeding was performed that is necessary to keep the plants growing and free from grass and weeds. Notwithstanding my section was visited with the hottest summer ever remembered and almost the driest known, only a small proportion of the plants which became well established succumbed. The growth was all that could be expected under the circumstances. One or two blossoms made their appearance late in the fall. No very material difference could be noticed when winter set in between the plants raised in the box and those grown without transplanting. About the 1st of December a light covering of straw was placed on the plants as a winter protection. In consequence of the open and warm winter the foliage was not killed (only slightly injured), and they have already started on the new growth, quite visible through the straw. As to the hardiness to stand winter and the amount of covering necessary, the one just closed furnishes nothing definite.

OHIO. Cincinnati, March 13, 1882.—Adolph Leué.

The seed of both *P. roseum* and *P. cinerariæfolium* was sown on Clifton Hights, each package upon one square rod, the soil consisting of yellow clay, which I mixed with rich black soil and well-rotten cow manure. The whole was spaded, hoed, and raked. Time for sowing, first week of May. The ground was kept mellow and free from weeds, which was easily done, as the seeds were sown in rows 15 inches apart. Although the ground was sprinkled in the evenings when sprinkling was necessary, none of the seeds came, which I attribute not so much to the cold nights we had as to the severe heat, as the ground had no shade whatever.

ONTARIO. London, March 5, 1882.—William Saunders.

Has *P. roseum* growing. "It seems to stand our winters very well."

EXPERIENCE WITH THE PLANTS IN WASHINGTON.

Our own experience in our private garden at Washington has been far more satisfactory than we anticipated. The seed of both species sown, whether in the fall of 1880 or in the spring of 1881, germinated tolerably well, though some was evidently worthless when received. A few plants of *roseum* from that sown in the fall of 1880, bloomed the ensuing autumn, while all sown in the spring of 1881 bloomed profusely the present summer. The colored plates have been drawn from these plants.

Both species withstood the past two winters very well, and as these were extreme winters, the one very severe and cold, the other open and mild, the test may be considered a very thorough one. The older leaves died off, as is the custom with many allied perennial species, but the plants began growing very early in spring and were, in fact, among the vernal adornments of the garden. *Roseum* began blooming early in May, and showed every variation in color from almost pure white to deep crimson. It also showed considerable variation in the green of the leaves as well as in the form, some plants having the leaves much more finely cut than others. *Cinerariæfolium* which has a much smaller flower, with pure white petals, very strongly resembling the common Ox-eye Daisy, began blooming a month after *roseum* had passed its prime. It proved uniform in color, and is always distinguishable from *roseum*, even before blooming, by the whitish or glaucous green of the leaf, and its much deeper and broader incisions. Neither of them has entirely ceased blooming at the date (June 30) this report is submitted, though but few flowers of *roseum* remain.

A portion of the flower heads were dried and pulverized, the powder proving to be fully equal in efficacy to the imported article; while the powder from dried stems and leaves is decidedly weaker, but still useful when applied in large quantities.

SPECIAL EXPERIMENTS.

The following experiments with the California and imported powders were made at Kirkwood, Mo., under our direction, by Miss M. E. Murtfeldt:

On larvæ of *Heliothis marginidens*—which appeared in unusual numbers during the months of May and June, and almost devastated the rose gardens in this section—the powder was very effective where it could be thoroughly applied; but the habit of the young larvæ of boring into and hiding within the buds rendered its application difficult and but partially successful in ridding the bushes of the pest. When diluted with two parts flour or air-slacked lime to one of the powder it produced but little effect unless applied while the dew was still on the plants, which caused it to adhere in greater quantities and produced the usual sickness and irritation.

For *Selandria rosæ*, the pure Pyrethrum is a good remedy where it can be puffed on the underside of the leaves where the slugs rest. They are not easily killed by it, however. It is not very effectual in keeping off the flies, as the volatile essence is soon dissipated in the open air, after which the flies regard it no more than so much dust.

A small Dipterous leaf-miner, which has for years been very destructive to the foliage of the Verbena, was kept off the plants by one or two liberal dustings with the powder upon the first appearance of the mines upon the leaves. All Diptera seem to be peculiarly susceptible to the influence of Pyrethrum.

Its effect on the Striped Flea beetle (*Haltica striolata*), which riddles the young leaves of cabbage, cresses, and other cruciferous plants, is rather to drive the beetles off than to kill them. It seldom absolutely kills them, but if thickly applied, it produces temporary stupefaction. There are at least two successive broods of this beetle, appearing in greatest numbers during the latter part of May and of July; and if the powder be applied occasionally to plants liable to attack at these seasons a great deal of injury may be averted. There are, of course, premature and belated individuals to be seen throughout the summer, but the regular broods only are seriously destructive.

The powder is equally effective in causing the Cucumber Flea beetle (*Haltica* (*Epitrix*) *cucumeris*) to give such plants as have been treated a wide berth.

On the common Tomato worm (*Sphinx 5-maculata*) the powder was rather slow to take effect. From ten minutes to half an hour often elapsed before the usual restlessness and ejection of visceral fluid was observed, but violent sickness, followed by paralysis, was sure to occur, from which very few, so far as I could discover, ever recovered. The larvæ would remain in one position motionless, except for slight muscular jerking, for many hours, after which they would fall to the ground, and, in most cases, by the second or third day, shrink up and die. The younger the larvæ the more rapid the effect of the powder.

On *Datana ministra* the effect of Pyrethrum was not usually fatal. It produced some sickness and lethargy, but unless very thickly dusted with it the caterpillars usually recovered.

Tested the powder on half-grown larvæ of *Agrotis inermis* which were concealed under chips and stones for hibernation, and in less than three minutes it produced violent sickness and convulsions, resulting in death in about an hour. I am convinced that if plants liable to be cut off by this worm could each have a little of the powder sifted around the stems they would be safe. All noctuid larvæ succumb quickly to its effects where it is directly applied. The difficulty is to put it where they will be sure to come in contact with it.

My experience in the use of Pyrethrum for the destruction of the various species of Cabbage worms and the Cabbage Aphis coincides with that of last year. It is as good a remedy as one could wish, and has the advantage over most other insecticides of being perfectly harmless to human life—a great desideratum in any substance that has to be applied to leaves or blossoms (as in the cauliflower) that are used as food.

As an exterminator of all kinds of house flies (*Musca domestica*, *M. cæsar*, and *Stomoxys*), as well as mosquitoes and other gnats, it has no equal. For all species of *Aphididæ*, upon which I have tested it, it is also a specific, used either as a powder or fumigator.

Insects upon which it produces little or no Effect.

Most hard-shelled beetles and bugs resist its effect, although it is evidently distasteful to them and will cause them to desert the plants to which it is applied.

All hairy larvæ upon which I have tested it seemed but slightly, if at all, affected.

The larvæ of the Jumping Sumac beetle (*Blepharida rhois*, Forster) are not in the least disturbed by being thoroughly dusted by it, their excrementitious covering being impervious to its effects. Nor do they seem to object to it as seasoning for their food. Paris green in quite large proportions, with flour or air-slacked lime, is the only remedy I have found effectual against this disgusting and destructive pest.

Dermestes and *Anthrenus* larvæ will live for weeks in a close box half filled with the powder.

The larvæ of Angoumois Grain-moth (*Gelechia cerealella*, Linn.) are not susceptible to its effects either as fumes or powder.

All these experiments, excepting the two last mentioned, were made in the open air, as I should not consider any others conclusive as to the value of the preparation for practical purposes.

JUNE 10.—Our Purple Fringe (*Rhus cotinus*) is covered with the disgusting larvæ of *Blepharida rhois* to which I administered a thorough dusting of the Persian insect powder obtained from our druggist. An examination after several hours showed the larvæ feeding as greedily as before, and apparently experiencing no inconvenience from the particles of powder that adhered to their slimy and stercoraceous coverings. The powder used may have been too old or too much adulterated.

The same powder applied to the Rose slug, while it did not kill the larvæ, nor produce any very sudden effect, seemed to diminish their voracity, as plants thoroughly dusted in the evening showed but little mutilation on the following morning, while plants that had not been dusted were seriously skeletonized. Some of our neighbors who have used the pure Pyrethrum powder consider it the best of all remedies for this garden pest.

JULY 7.—Used the powder freely on some plants of Sweet Elysium that were being ruined by the Striped Flea beetle (*H. striolata*). It did not produce any immediate paralyzing effect, but evidently caused the beetles to "vacate," as none of the latter were to be found on or about the plants on the succeeding day.

JULY 18.—The "Striped bug" (*Diabrotica vittata*) on cucumber and squash vines does not seem to be disturbed by it.

SEPTEMBER 24.—Having received from Mr. Riley a package of Milco's pure Pyrethrum powder I proceeded to test it on various larvæ infesting cabbage.

Placed in a large jar a head of cabbage crowded with larvæ of all sizes of *P. rapæ* and *P. protodice*. These were dusted freely with the undiluted powder, the jar being left uncovered and in the open air. Examined in about ten minutes and found most of the larvæ jerking themselves from side to side in evident uneasiness and discomfort. A half hour later most of the *protodice* larvæ had dropped from the leaves and were apparently very sick, ejecting a dark green fluid from the mouth.

The *rapæ* larvæ had all ceased to feed and some of these also were sick, though as yet not so seriously as the other species.

SEPTEMBER 25.—*Protodice* larvæ nearly all dead this morning. *Rapæ* have fallen from the leaves and seem paralyzed. They do not recover even when removed from the jar and freed as much as possible from the Pyrethrum.

SEPTEMBER 26.—All the small larvæ are dead. Those in a more mature stage are still alive and squirm when touched, but otherwise lie motionless on the bottom of the jar. It is singular, however, that one larva that had suspended for change did not seem injuriously affected by the powder, although it received a liberal quantity, but completed its transformation and appears to-day as a healthy chrysalis.

OCTOBER 5.—Prepared an infusion of an even tablespoonful of the powder in a pint of water and applied it to larvæ of *rapæ*, which are ravaging our turnips in the garden. Selected some isolated plants and gave the leaves and worms a thorough drenching. Examining them four or five hours later I find only the smaller larvæ showing signs of sickness. The leaves have dried and show but little trace of the powder, except in their axils where it settled, and the worms are feeding from them with undiminished avidity.

The same solution was tried on a lot of *protodice* and produced much greater effect. By the next morning most of them were dead, and those not fatally affected had deserted the plants and were crawling on the ground, evidently in search of food not so disagreeably flavored.

OCTOBER 9.—Dusted with the dry, unadulterated powder several plants that were badly infested with both species of *Pieris*, and found in the course of a few hours every worm either paralyzed or deserting the plants. I think the powder preferable to the liquid, but it can only be used economically on still days.

The other insects affecting cabbages and turnips, such as *Plusia brassicæ* and *Plutella*, succumbed very speedily to the influence of the powder.

Have also tried the powder on *Heliothis* on rose, and wherever the larva was exposed so that the Pyrethrum came in contact with it it invariably produced sickness and paralysis, and eventually death. The same effect was observed in the case of *Datana ministra* on oak and *Notodonta unicornis*.

For all kinds of *Aphides* it seems to be a specific.

On *Lytta atrata* and other blister beetles it failed of the desired effect. So it also did in the case of Red spider and Scale insects. It might be efficient on the latter if applied when the young were spreading over the plants.

No other device or application will so quickly rid a room of flies and gnats, but with us it *did not* prove a remedy for Red ants, which are our greatest household pest.

CHINCH BUG NOTES.

PREDICTIONS IN RELATION TO INJURY.

In the *American Entomologist*, October, 1880, and also in his annual report for that year, submitted December 30, Professor Thomas, after a study of the relations between the annual rainfall and temperature and the years of Chinch Bug injuries, extending over a series of forty years, arrived at the following conclusions:

As a general rule the Western farmer may expect the Chinch Bug but once in excessive numbers during a "septenary period," or period of seven years (occasional exceptions). There is a strong probability, amounting almost to a certainty, that there will never be two destructive years in succession, since two successive dry years are necessary to develop the insect in great numbers, and the records seldom show three dry years in succession. He then prophesied that 1881 would be a year of severe damage.

As we have already shown (*American Naturalist*, October, 1881), the bug did great damage in several of the Western States in 1881, especially in Kansas, where a Chinch Bug convention, the first ever held in the United States, was convened at Windsor. A resolution was unanimously adopted to exclude wheat from the growing crops. The length of time was not mentioned, but it is understood that the planting will be resumed at the earliest possible practicable period. Anticipating that this would be a bad Chinch Bug year, Professor Thomas recommended the sowing of a large area of oats, and had this advice been more generally adopted, it would probably have been of great benefit to the farmers of that region. It is a curious fact that Professor Thomas' own State (Illinois) was the only one of the large oat-producing States in which the acreage of this crop was not increased, but somewhat diminished.*

INJURY IN SPRING OF 1882.

During the months of April and May, 1882, in spite of the fact that 1881 was a destructive Chinch Bug year, and in spite of frequent rains,

*In remarking (*Ibid.*) upon the abundance of the bug in 1881 we also mentioned the fact that it was noticed by Mr. Schwarz in July in great numbers on "Sand oats" and other grasses growing on the dunes at Fortress Monroe, Va., and also that it was observed in considerable numbers in August in the rice fields near Savannah, Ga., by Mr. Howard.

it looked as if we were already to have a marked exception to the rules just laid down. The bugs appeared in large numbers in parts of Illinois, Kansas, and Missouri, as the following extracts from our correspondence will show, the agricultural papers containing many similar reports and expressions of alarm:

Large numbers in the wheat-fields south of this.—(Marion County, Illinois, March 12.)

I hear of Chinch Bugs already having begun their depredations upon the wheat. Some of the farmers tell me the "little red ones" are in great force.—(Washington County, Missouri, April 27.)

This is the 1st day of May, and our fields are alive with chinches, which will doubtless destroy a large per cent. of the growing wheat and incoming corn crops, leaving the country in a starving condition. I never saw chinches as numerous so soon in the spring, and I am an old settler in this country. The universal cry is from far and near, "What will become of us?" "What can be done so corn may be raised?" Heavy rains may come and save us, but in the event this fails this country will be ruined. Can you suggest a remedy?—(Johnson County, Missouri, May 1.)

Could you give us any information with regard to Chinch Bugs? To-day *the air is full of them*.—(Neosho County, Kansas, May 5.)

The Chinch Bug is doing much damage in this part of the country.—(Smith County, Kansas, June 10.)

June reports were, however, with some few exceptions, less alarming, and the rains seem to have accomplished their work in destroying the bugs over most of the Northwest, so that 1882 will in all probability not prove an exceptional year. The exceptional injury that continued through June was mostly in Missouri and Kansas, and, in view of its severity in parts of the former State, we wrote to one of our special observers for an account of the weather there in early spring and summer, and append his reply:

CADET, WASHINGTON COUNTY, MISSOURI.

DEAR SIR: Your favor of June 6 is received. With respect to the meteorological conditions prevailing early spring and summer, I beg to state that the winter was mild; the month of March was unusually warm. The early part of April warm until about the middle of the month, when rain set in, which lasted something like two weeks. Most of the rain was very heavy and cold. The early part of May was colder than usual. There occurred severe frosts upon three or four nights; ice was formed; two-thirds of the newly-formed peaches were killed, and all potato vines killed to the ground. Then occurred a spell of unusually hot weather, with now and then a heavy, dashing shower. This kind of weather lasted till the end of June.

Chinch Bugs persevere. It would surprise you to see how beautifully and steadily their progress is shown across an oat field here. To see the strip *whiten* and *widen* from day to day would interest an enthusiastic naturalist, but a farmer—"not much." As they suck a strip dry and white, they leave it; none can be found in the strip. Their motto is, "Forward." When they have begun to march they do not "look back." A neighbor is trying to keep them in check among his corn. He is at least rendering their lives miserable. He has got a turning plow, and plows pretty near the corn, and dashes the soil against the stalks, and makes as great a commotion as he knows how in the hope of at least thinning them a little. After all he is not very sanguine of success.

Yours respectfully,

J. G. BARLOW.

Prof. C. V. RILEY.

The appearance of the chinches in early spring in such numbers is not astonishing when we consider the great numbers in which they occurred last season.

REMEDIES AND PREVENTIVE MEASURES.

Concerning irrigation as a remedy, and concerning preventive measures, we quote from a recent article which we communicated to the *American Agriculturist* (December, 1881).

I have found no occasion to change my opinion as to the value and potency of irrigation as a remedy for Chinch Bug injuries, a remedy, too, that is within the reach of most farmers, for there are few who might not, with the aid of proper windmills, obtain the water requisite for irrigating their fields at the needed time, while many have natural irrigating facilities. I have repeatedly laid stress in my writings on the importance of irrigation in combating several of our worst insect enemies, and aside from its benefits in this direction, every recurrence of a droughty year, such as the present, in large portions of the United States, convince me of its importance as a means of guarding against failure of crops from excessive drought. I am glad to know that many farmers, and especially small fruit-growers in the vicinity of New York, are preparing in one way or another for irrigation whenever it becomes necessary, and I was pleased to hear Dr. Hexamer, at the late meeting of the American Pomological Society, urge a general system of irrigation as the most profitable investment the cultivator can make in a climate subject to such periods of drought as ours is known to be. When it comes to prevention a great deal may be done during the winter season in burning the hibernating bugs, and, as remarked elsewhere, I cannot lay too much stress on the importance of winter work in burning corn-stalks, old boards, and all kinds of grass, weeds, rubbish, and litter around grain fields, and even the leaves in the adjacent woods, in and under all of which the little pest hibernates. Next to drowning out the rascals, cremation is undoubtedly the most effectual mode of destruction. Next let the spring wheat be sown as early as possible and the ground rolled. The rolling will apply equally well to the culture of winter wheat, though I would not advise the early fall planting of the last in sections where it is likely to suffer from Hessian Fly, for reasons not pertinent in this connection. Sow thickly, as the more the ground is shaded the less the Chinch Bug likes it. If in late winter the bugs are known to be numerous, so as to bode future injury—and the fact can be easily ascertained by the ill-savored odor they send up from the corn-shocks, and by their general presence in the wintering places mentioned—it will be well to plant no wheat or barley. In short, just in proportion as we adopt an intelligent and cleanly system of culture, just in that proportion will the Chinch Bug become harmless; it is, in great part, and in its more serious aspects, a result of slovenly husbandry, and will lose its threatening character in the more Western States, as it has in those east of us, just as fast as more careful and intelligent husbandry becomes the fashion.

We have no doubt but that the kerosene emulsion, which will be described further on under the head of Orange insects, may be used to good advantage against the second brood when it is developing in corn above ground, by being sprayed in proper dilution with force upon the plants.*

THE ARMY WORM.

(*Leucania unipuncta* Haw.)

Order Lepidoptera; family Noctuidæ.

[Plates II and VI.]

As we have been preparing for the third report of the Entomological Commission, and for a special bulletin, an extended account of the Army Worm, and as it has been quite prevalent and destructive in several States during the present spring and summer, or while this report is being prepared for the printer, we have concluded to extract in advance from the aforementioned bulletin portions referring to the habits and natural history of the species, and to add the results of special observations made during the past two years, as well as an interesting and popular account of the invasion of 1880, which the Rev. Samuel Lockwood, of Freehold, N. J., has been kind enough to send us for publication. We commend this last for the accurate observations it contains and for its many facts both as to the habits of the insect and the meteorological conditions under which it prevailed that year. We also reproduce the colored plate designed for the Commission report.

* Since this was written we have urged its use for this purpose upon Prof. S. A. Forbes, the recently-appointed State entomologist of Illinois, and he reports admirable success with it.

HABITS AND NATURAL HISTORY.

It was not until 1855 that the first step towards ascertaining definitely the life-history of the Army Worm was made, although it had been destructive at intervals for more than a hundred years before.

In this year John Kirkpatrick reared the perfect moth from the destructive worm, and described both pupa and adult in the Ohio Agricultural Report for the same year. Our more extended knowledge of the subject dates, however, from the great Army Worm year of 1861. In this year Walsh, Kirkpatrick, Thomas, and Klippart at the West, and Fitch and Packard at the East, all improved their opportunities for studying the worm. To Walsh we are particularly indebted for a study of its parasites, though his views of its natural history have proved singularly unfortunate. To Fitch is due the credit of the correct scientific naming and the discovery of the synonymy. Kirkpatrick first described the most important of all the parasites—*Nemoræa leucaniæ*—and, in the light of later developments, he was singularly correct in his ideas as to the number of broods and method of hibernation.

Yet up to 1876 no definite knowledge, based on observation and experiment, existed on some of the most important points in the natural history of the species. The eggs and the mode and place of oviposition were unknown; the question of hibernation and of the number of annual generations was still as open to discussion as when so warmly debated by Walsh and others, and many minor matters remained unsettled. Since 1876 we have been able to replace uncertainty in these directions by positive knowledge, so that there are no questions having any important practical bearing that are now mooted in respect of this insect.

CONCERNING THE EGG [Plate VI, fig. 3.]

WHEN AND WHERE THE EGGS ARE LAID.—The favorite place to which the Army Worm moth consigns her eggs in wild or tame grass or in grain is along the inner base of the terminal blades where they are yet doubled, or between the stalk and its surrounding sheath. They are by no means strictly confined to these situations, as is shown by the fact that we have known the moths in breeding cages to oviposit in crevices on the side of sward which had been cut with a knife, or even between the roots. In our first observations, which were made in low blue grass, the eggs were almost invariably found in the fold at the base and junction of the terminal leaf with the stalk; but later they were found thrust down between the sheath and the stalk, and occasionally in the natural curl of a green leaf or the unnatural curl at the sides of a withered leaf.

The rankest tufts of grass, caused in pastures by the droppings of cattle and sheep, are preferred by the moth for oviposition, and in these tufts the oldest and toughest stalks; and in grain-fields also the ranker growth caused by an accumulation of manure at some one spot, or the previous existence of some fodder heap or the like are preferably chosen.

The observations of the present spring have satisfactorily proven that early in the season the moths oviposit by preference in the cut straw of old stacks, in hay-ricks, and even in old fodder stacks of corn-stalks. Old bits of corn-stalk upon the surface of the ground in pastures have been repeatedly found, both in the vicinity of Washington and in Northern Alabama, with hundreds of eggs thrust under the outer sheath or epidermis, while the last year's stalks of grass in the fields around Washington have been found to contain these eggs in similar position. The evidence collected in 1875, and published in our Eighth Missouri Report, seemed to show that where fodder stacks existed in grain-fields the worms originated from them or from their near vicinity, and the observations just mentioned prove the correctness of the inference then made.

It has, however, been proven by this spring's observations, that, lacking both stubble and fodder stacks, the moth can and does oviposit in spring in young winter grain. Mr. A. Koebele found, in March, in the vicinity of Savannah, Ga., newly-hatched larvæ in the center of an oat-field, the grain being one foot or more in height, and no straw stack in the vicinity.

As stated in the *American Entomologist* (III, p. 214), the moth will also, when exceptionally numerous, lay her eggs without concealment, and upon plants, such as clover, which the larva does not ordinarily relish. As an instance of this we stated in a foot-note that we had recently received from Professor Lintner, State Entomologist of New York, what were apparently the pressed eggs and egg-shells of this moth, thickly covering clover leaves and mixed with an abundance of white gummy matter, with which the moth usually secretes them, all indicating that the moths had in this instance (doubtless from excessive numbers) "slopped over."

Remaining concealed during the day, unless disturbed, or except in cloudy weather, the moth begins to fly at the approach of night, and, as far as observations have indicated, is engaged in ovipositing most actively during the earlier part of the night. It was at five or six in the afternoon when the first moth, in 1876, was discovered in the act of egg-laying, but they have since been found at work most often in the early night hours. The time of year when the eggs are laid will be discussed in Chapter V (of the special Bulletin), under the head of "Number of Annual Generations."

MODE OF OVIPOSITION.

We have already described the compressed horny ovipositor of the female which plays with great ease upon the two telescopic subjoints of the abdomen. This organ, in the act of oviposition, is thrust in between the folded sides of the grass blade, and the eggs are glued along the blade in rows of from fifteen to twenty and covered with a white, glistening, adhesive fluid, which not only fastens them together but draws the sides of the grass blade close around them, so that nothing but a narrow, glistening streak is visible. This attempt at concealment is always made where the eggs are deposited in the leaf; but where they are thrust down between the sheath and the stalk, or otherwise naturally concealed, the gummy fluid is often very sparsely used, and sometimes not at all.

We have stated the number of eggs in a string at from fifteen to twenty, and this we believe to be about the normal number; but we have known as few as two or three to be deposited in confinement, and large batches of nearly a hundred eggs in from three to eight rows have been found in bits of corn-stalk.

We have elsewhere expressed the opinion that the grass blades may possibly be clasped by the opening hind border of the ovipositor, so as to give the insect a firmer hold and close the leaf more firmly on the eggs, but more recent actual observations, in the field, of the movements of the moth during oviposition indicate that this opinion is not well founded. She walks or flies around in the grass, alighting every few moments, until she finds a place that satisfies her. She then clasps the blade, the head almost invariably upward, or in the same direction with the blade. The front pair of legs clasp the blade forward, the middle pair about the middle of the abdomen, and the hind pair about the tip of the abdomen, the wings being partly open meanwhile. The leaf is thus folded by the middle and hind legs, while the abdomen bends and the ovipositor is thrust in, as already described. She is thus engaged from one to three or four minutes at a given spot, according to the number of eggs laid, and then flies a short distance and in a few minutes lays another batch. As we have known thirty eggs to be laid in two minutes, it would not require many hours to empty the ovaries, and a given female probably lays all her stock of eggs in one or two nights, though the time will vary with temperature and other conditions. We have known the moth to be so fixedly engaged in supplying a piece of old stubble with her eggs that she was unable to disengage herself when first disturbed, and she was always sufficiently intent on the operation to render observation with a "bull's eye" sufficiently easy.

PROLIFICACY.

It is evident, when we consider the immense numbers in which the Army Worm often occurs, and when we also consider the number and importance of its natural enemies, that the moth must be quite prolific. The only recorded statement, however, is that in the Eighth Missouri Report (p. 34), where the number of eggs indicated by a single dissection is stated to be upward of 200. That this dissection, however, must have been made too early or too late is shown by the fact that two dissections made the present spring showed 737 eggs in the ovaries of one female and 562 in the other.

DURATION OF THE EGG STATE.

Observations made in Missouri in 1876 indicate that the worms hatch from the eighth to the tenth day after the eggs are deposited, while others more recently made in Washington make the average duration of the egg in the month of May just one week.

HABITS AND PECULIARITIES OF THE WORM.*

HABITS WHEN YOUNG.—When the eggs have been laid in a green grass blade, the larvæ on hatching feed for a time in the fold of the leaf.

* It will be interesting and important in this connection to translate Guenée's generalizations on the larvæ of this genus, as they may serve to help us to a more accurate judgment concerning one or two points in the life history of *unipuncta:* The larvæ of Leucania are all closely related in appearance, and even the most expert entomologist is often deceived by them. No European species, to my knowledge, is of a green color; all have a white dorsal stripe, and are of carneous or brownish gray, with the ordinary lines well continued and well marked, and between the lines a number of other lines or supernumerary bands, often resulting from a massing together of brown or reddish atoms. These usually constitute all the markings, but often the subdorsum is filled with black marks which are not continued upon the rest of the segment. The stigmata are often wholly black or brown. These larvæ live exclusively upon the Gramineæ, and are to be found upon those which grow with their roots almost in the water, as well as upon those growing only upon the driest hillocks. Those which form thick tufts afford a natural shade, in the midst of which the caterpillars pass their lives, climbing to the extremity of the leaves only in the evening or even at night. Those which live on grass with sparse leaves by which they are not sufficiently shaded, hide

Where they hatch in the stubble or old stalks they remain sheltered therein for three or four days, issuing at night to feed but going back for shelter. The newly-hatched worms were also found under the frayed bark of the cedar posts around a wheat-field at Huntsville, Ala., in such numbers and at such an early age as to indicate that they had hatched there. At this stage they are whitish in color, walk like loopers in consequence of the atrophied, or rather non-developed first and second pairs of pro-legs, drop suspended by a silken thread, or curl up when disturbed. As has been so often said, during the early part of their lives the larvæ are very similar in their habits to the many species of cut-worms, working upon the leaves of grass or grain during the night or in cloudy weather, and hiding during the bright sunshine.

The fact cannot be too strongly impressed that the traveling of the worms in large armies is abnormal. During nearly the whole year in regions subject to their incursions the worms may be found in grass-fields, high or low (perhaps more often in the lowlands bordering marshes, as they are here less liable to disturbance), feeding in the normal cut-worm manner. If their numbers be small they may pass their entire lives in this manner, for it is only when so very abundant that the food of the vicinity is destroyed that the worms march in search of further supplies. Ordinarily one may pass daily through a grass plot where they abound and never suspect their presence until the plot begins suddenly to look bare in patches. Thomas, in his first Illinois report, states that, although he particularly looked for the worms during June, 1875, he never suspected their presence in a constantly frequented grass plot behind his house until it was made manifest in this way, by which time the worms had disappeared, the abundance of their excrement, however, showing well enough that they had been there. From the fact that the marching is abnormal it always happens that in marching years many farmers insist that the sedentary worms ravaging their fields are not the true Army Worms, but simply the "ordinary cut-worms" which they have with them every year.

When young the worms resemble quite closely in color the plants upon which they feed, and this, with the habit of hiding as they do by day, and dropping when disturbed, renders them very difficult of detection. The lighter color of the young worms found thus concealed has given rise to the theory put forth by Thomas and others, that the marching worms belong to a distinct race of the species; but there is not a particle of reason in such a theory, for the worms of the marching bodies possessed the same light color originally, and indeed the variation is such that the same color frequently persists with the full-grown worms, whether of the marching bodies or of the normal hidden individuals. The deep color is largely the result of exposure, and whether the sedentary or marching habit predominate, depends entirely upon circumstances.

themselves under brush or dry leaves a little distance away. Finally, some of them which eat the leaves of aquatic grasses hide themselves within the stalks, the tops of which have been cut off by the hand of man or broken off accidentally. They bury themselves until stopped by a node, and their excrement, which partly fills these tubes, bears witness to the fact that they only leave their dwelling to take their food. This retreat, if it is not guarded from the punctures of the Ichneumons, at least completely shelters them from the attacks of birds; but this is not its only use, for they utilize it still more when they reach the time for metamorphosis. They do not bury themselves in the earth like their congeners, but content themselves with spinning below and above them two little partitions mixed with frass. The Leucanias which are ready for pupation in the latter part of the season pass through the winter in the larva state, and only undergo the metamorphosis in the spring.

DURATION OF WORM LIFE.

With so widespread an insect as the Army Worm it is impossible to make any general statement concerning the duration of any one stage which will hold good. In Saint Louis, in the vivarium, at an average temperature of 80° F., we found that certain of the worms passed through their five molts at intervals of three days, making the entire length of the larval life fifteen or sixteen days. The development, however, even of those hatching at the same time from the same brood of eggs is quite irregular and may occupy several days longer. In Northern Illinois, Walsh gives the period at from "four to five weeks," while the shortest period of larval life that Thomas has observed is twenty-eight days. Individuals reared at the Department of Agriculture indicate that in this latitude in late spring the period is from twenty to twenty-five days. Everything depends of course upon the temperature, the midsummer individuals passing through their changes much more rapidly than the spring and fall broods. As we shall show later, the Army Worm most often hibernates in the larva state, consequently the larval life of the last brood frequently extends over a space of four months or even more. In addition to the details published in our eighth and ninth Missouri Reports, the following observations recorded this spring will illustrate the great variation referred to.

Some eggs of the Army Worm moth, which were deposited May 4, 1882, hatched May 11. The worms passed their first molt May 17, the second May 20, the third May 23, the fourth May 26, and the fifth May 29. On June 2 some of the larvæ had entered the ground, and June 17 eight moths issued.

May 28 some moths collected during the evening of the 27th were placed in the vivarium with grasses. June 3 many young larvæ had already hatched, and on June 20 some had entered the ground for pupation.

REMEDIES.

BURNING OLD GRASS, ETC.—That fields which have been burned over in the winter are free from the destructive presence of the worm is a fact in the history of its visitations. But opinion has varied as to the precise effect produced by burning over. Walsh, as we have already shown, always urged this remedy of burning over, thinking that it destroyed the eggs. The next phase was that suggested in our Eighth Missouri Report, where, after showing that the eggs are preferably laid in old grass-stalks or stubble, the inference was plain that the appropriate nidus would be destroyed by the burning.

Now that larval hibernation is established, however, we can readily see that the fires would destroy these hibernating larvæ and prevent the appearance of the moths and of a second destructive brood from them. But we must not suppose that the burning over would prevent *all* appearance of the worm; it merely prevents its appearance in destructive numbers. The moths will, when exceptionally numerous, lay their eggs without concealment and upon plants, such as clover, which the larva does not relish. In such cases of exceptional abundance we may well suppose that the moths will fly into fields which have been burned over and supply them with eggs; but the instances in which this would result in material damage to the crop would be very rare.

"As the Army Worm appears in vast numbers during certain years only, and at irregular intervals, and as this appearance is rather sudden and seldom, if ever, anticipated by the farmer, burning as a remedy loses much of its importance, except where it is practiced annually; and in view of the benefit of such burning in destroying chinch bugs and other insects it is to be regretted that the practice of winter burning of fields, prairies, straw-piles, weeds, and other litter and rubbish does not more generally prevail; the destruction of injurious insects by such a system would far outweigh the benefit derived from plowing these stalks and weeds under or leaving them to gradually decay."—[8*th Mo. Rep.*, *p.* 55.]

PREDICTIONS; METEOROLOGICAL INFLUENCES ON THE SPECIES.—What we still need to know, in order to make the burning over of much avail, is some method of actually predicting the coming of the worms. That climatic changes have much to do with disastrous years is indubitable, yet it is very evident from facts we have given that Fitch's theory will not hold. We have shown that he had no practical knowledge of the subject, and that his theory was hurriedly thrown together. We are also not inclined to admit the truth of Professor Thomas' weather arguments in the case of Army Worm. The most we can say, after a careful review of past years, is that all, or nearly all of the years of Army Worm abundance have followed dry years, the nature of the year in which they actually occur having little or nothing to do with it. This, however, helps us only so far as to enable us to say that after a year of exceptional drought the worms *may* appear in injurious numbers. We are still very far from saying that after such a year the Army Worm is a necessary consequence, so that for practical purposes we are still almost as far in the dark as formerly.

In short, however interesting it may be to speculate as to the weather, no well-informed person will pretend to a sufficient sibyline insight into the future to enable him to act with absolute confidence as to results. The pretensions of a Tice or a Vennor must be classed, in the light of whatever there is of science in meteorology, among the utterances of charlatans and quacks, and whatever the tendency may be for history to repeat itself, so far as weather and season are concerned, the records sufficiently show that there is no absolutely relying upon the weather of the future. Insect probabilities in connection with meteorological speculation offer a most inviting field for theory and speculation for those who have few facts to lean upon, but it can never be safe to anticipate for more than two or three months ahead at the most. It is quite possible, from the observed facts during the winter and early spring, to form pretty accurate conclusions as to what may happen the ensuing summer so far as the Army Worm is concerned, and this is especially true when the preceding summer and autumn have been exceptionally dry. This may be illustrated by the following opinion, quoted from an article which we published in the *Rural New-Yorker* of May 27, which subsequent events have fully justified:

Anent the Army Worm I have obtained many interesting facts during the past winter and present spring, which all go to confirm the correctness of my previous conclusions and inferences, especially those of 1880, as presented to the American Association for the Advancement of Science, viz., that it hibernates principally in the worm or larva state. From the fact that the worm of all sizes has been found throughout the past winter not only around Washington but in various parts of the South, whenever it has been looked for carefully, and from the further fact that the moths have lately been very numerous and active in laying their eggs in this immediate vicinity, I drew the inference, some weeks since, that we should have in most parts of the country serious attacks of the insect during the present year, and sent an item containing this inference to the American Naturalist for publication. In confirmation of the correctness of that inference the Department of Agriculture has just received accounts of alarming injury to small grain in Northern Alabama and Georgia as well as in Arkansas. If the spring and early summer prove in any way wet (as is likely in the country which suffered so much from drought last year) the precise conditions will recur that have in the past marked all great Army Worm years.

Observations which I have recently been making with one of my assistants, Mr. A. Koebele, fully establish the fact which I inferred to be the case in 1877—that the moth secretes her eggs by preference in old grass and stubble and even in corn-stalks; and this explains two facts that have long since been recognized by practical men, viz., that the worms in destructive numbers are apt to originate from old stacks or piles of corn-stalks, or coarse manure, to which the early moths are attracted for purposes of oviposition. In short, a field will be free from the worm in proportion as it is kept clean of old stubble and straw, and in proportion as it is distant from such, or from neglected pasturage, or low, rank grass inaccessible to cattle.

Believing, therefore, that serious injury now threatens meadows and grain fields from this insect, and that we shall hear of it farther and farther north with the heading out of wheat, and knowing, from experience, that an ounce of prevention is worth a pound of cure, I recommend that farmers generally take the precaution to burn up or plow under at once, wherever it is possible to do so, any neglected meadows, old grass or straw upon their farms; further, to roll the grain in the vicinity of old stacks where these may not be burned. Let me add, further, that one must not be deceived by appearances. The worms may not be visible to an ordinary observer, or even to a careful one, and may yet abound in myriads, for they secrete themselves within old stalks, or folded leaves, when very young, and hide under matted grass or grain when larger. Yet a field that shows none now may in a fortnight be overrun with full-grown worms, so rapidly do they grow.

While, therefore, annual burning in the fall or winter is to be recommended as a haphazard way of reducing Army Worm injury, burning as late as possible in the spring is much more strongly to be recommended, especially during certain years, and following exceptionally dry seasons and special observations that have been made during the preceding winter.

DITCHING; COAL TAR; POISONING.—"The worms may be prevented, as a general thing, from passing from one field to another by judicious ditching. It is important, however, that the ditch should be made so that the side toward the field to be protected be dug under. About every three or four rods a deep hole in the ditch should be made, in which the worms will collect, so that they can be killed by covering them with earth and pressing it down. They may also be destroyed by burning straw over them—the fire not only killing the worms but rendering the ditch friable and more efficient in preventing their ascent. I have also used coal oil to good advantage, and the worms have a great antipathy to pass a streak of it. Many of my correspondents successfully headed them off by a plowed furrow 6 or 8 inches deep, and kept friable by dragging brush in it. Along the ditch or furrow on the side of the field to be protected, a space of from 3 to 5 feet might be thoroughly dusted (when the dew is on) with a mixture of Paris green and plaster, or flour, so that every worm which succeeds in crossing the ditch will be killed by feeding upon plants so treated. This mixture should be in the proportion of one part of pure Paris green to twenty-five or thirty parts of the other materials named. If used in liquid form, one tablespoonful of Paris green to a bucket of water, kept well stirred, will answer the same purpose, as also will London purple, which has the merit of being cheaper. These substances should, of course, be only used where there is no danger of poisoning stock, poultry, or other animals. Logs or fences over running streams, or irrigation ditches, should be removed, otherwise the worms will cross on them.

"From experiments which I have made I am satisfied that where fence-lumber can be easily obtained it may be used to advantage as a substitute for the ditch or trench by being secured on edge and then smeared with kerosene or coal tar (the latter being more particularly useful) along the upper edge. By means of laths and a few nails the boards may be so secured that they will slightly slope away from the field to be protected. Such a barrier will prove effectual where the worms are not too persistent or numerous. When they are excessively abundant they will need to be watched and occasionally dosed with kerosene to prevent their piling up even with the top of the board and thus bridging the barrier. The lumber is not injured for other purposes subsequently."*

ROLLING; FENCING; ROPING.—Where the crop of a field has been completely destroyed by the worms, the plan of killing them by heavy rollers has been tried. This, however, is an expensive remedy and is not as satisfactory as might be supposed. Experiments on Long Island in 1880 proved that even where the ground was level the rollers soon became irregularly covered with mud composed of earth and of the juices of the crushed worms, so that the effect was much the same as if the ground had been uneven, and many worms escaped in consequence.

The remedy of "drawing the rope," as it may be termed, was practiced as long ago as 1770, and is described in Chapter II of the Bulletin in the quotation from Rev. Grant Powers. Although this remedy has been practiced from time to time since then we are not aware that any other account has been published. This spring it has been tried with good effects at Huntsville, Ala., and by Mr. J. W. Sparks, of Murfreesborough, Tenn. We quote from a letter from this gentleman describing his method:

> The Army Worm is making such inroads upon the wheat crop and other crops here in Middle Tennessee, I thought I would write you and give the process I have for ridding the wheat of these vagabonds. I take a rope about 60 feet long and cause two men to walk through the wheat field, dragging the rope over the wheat. By this means you can go over a large field of wheat in a few hours. The rope dragging over the wheat, shakes the worms off on the ground, and they curl up and lie there half an hour or more—seem to be mad about it—and then begin to move about hunting something to eat; but the larger ones are unable to climb the wheat stalks with all the blades off, so that you get rid of the larger ones the first time going over, and the smaller ones can be shaken off so often that they cannot hurt the wheat. If you will make known this simple plan to the sections where the worm is at work the people can yet save their wheat. I am satisfied I will save mine. I am going over my whole crop twice a day. My wheat is looking splendid, and if I succeed in whipping the worms I will make a large yield. You shall have full reports at the proper time.

In regard to this remedy it may be well to say that while tolerably efficacious when the worms are not present in overwhelming numbers, or when the crop is far advanced and the stalks are large and tough, under opposite circumstances it will be of little avail, and it will always be a question whether the portion of the crop saved by this means will be worth the great expenditures of time and labor which this remedy calls for.

As a fitting sequence to this general statement of the more interesting practical facts connected with the Army Worm, we introduce such letters and extracts of correspondence as are of sufficient interest for publication, and also, as intimated at the outset, a valuable account of the insect in New Jersey in 1880, by one of our esteemed correspondents, Rev. Samuel Lockwood.

REPORT OF OBSERVATIONS UPON THE ARMY WORM, 1881.

SIR: In accordance with your verbal directions, and the written order of the Commissioner of Agriculture given me July 23d, I started on the morning of the 24th for Chicago, Ill. Arriving there on the morning of the 25th, I spent the afternoon in interviewing the editors of the Farmers' Review and Prairie Farmer, with regard to the

* Quoted from previous articles by the author.

extent of country over which the worms had made their appearance, and in ascertaining the most profitable spot in the State to visit. I started on the morning of the 26th for Raub, Ind., a small station on the Kankakee line. Arriving at Sheldon, Iroquois County, Illinois, however, I was induced to stop by the accounts given by men at the station as to the abundance of the worms. I spent the whole of the 26th at Sheldon, and on the 27th went over to Kentland, Newton County, Indiana, where great damage was reported, and where I spent the morning in the field. On the evening of the 27th I returned to Chicago, where I found a letter from Prof. W. A. Henry, of Wisconsin University, in answer to a telegram I had sent him on the 25th asking about the northernmost appearance of the worms. His reply was that they were reported near Madison, and that the northernmost point from which they had been reported was Waupun. On the morning of the 28th started for Madison, reaching there in the evening. The next morning I ascertained that the Army Worm rumor in that locality was a false alarm. *Heliothis armigera* in sweet corn had been taken for *Leucania*, and the work of *Lachnosterna* in a few meadows had been supposed to be the work of the Army Worm. Learning from Professor Henry and the editor of the *Democrat* that the only points from which there had been newspaper reports of the worm in Wisconsin were Oshkosh, Whitewater, and Waupun, I obtained the address of a well-informed man in each place—one who would certainly have heard of the Army Worms had they made their appearance—and telegraphed to each for absolute information as to whether the worms had been seen in his locality, and the answer was in every case contrary to our expectations. Feeling quite certain, therefore, that the worms were not to be found in any number in the State of Wisconsin, I took the night train back to Chicago on the evening of the 29th, occasionally getting off at a station and making inquiries about the worms. I learned on my return to Chicago that the worms had been reported as doing a great deal of damage at Kalamazoo, Mich., so I bought my return ticket via Michigan Central and spent a night at Kalamazoo. The most diligent inquiry, however, on the spot failed to find me a man who knew of their presence.

EXTENT OF COUNTRY INJURED.—I failed, therefore, to find the worms in any other locality than in Northeastern Illinois, and across the border line in Indiana, and I am strongly inclined to believe that, outside of a belt embracing portions of Lasalle, Kendall, Grundy, Will, Kankakee, Iroquois, Livingston, and Ford Counties, Illinois, and Newton, Benton, Jasper, Warren, and Tippecanoe, Indiana, the damage was not very great, although the reports from Central and Western Illinois were quite alarming. From what I could learn of the reported appearance in Iowa, I believe that some other worm has been mistaken for the Army Worm in that State.

CROPS INJURED.—The oat crop seems to be the only one which has been appreciably injured. Some little damage has been done to corn, especially young sweet corn, and in some cases slight damage has been done to flax and millet. The timothy on pasture lands has also been somewhat eaten.

AMOUNT OF DAMAGE.—The damage to oats has in many cases been very severe. I saw fields of several acres which were not considered worth harvesting. At one place, seeing a steam thresher at work, I made inquiries, and found that they were averaging about two bushels to the load, when the proper amount should have been fifteen bushels. Dr. Bush, of Sheldon, states that, to the best of his judgment, the crop in Iroquois County has been damaged not to exceed ten per cent. This was indorsed by most of the men I met who were not farmers, the latter placing the damage at from 25 to 50 per cent. The total amount of oats in that part of the State will not fall behind the crop of last year, owing to a much greater acreage. Many farmers have put in oats on account of the failure of winter wheat. In the southern part of Newton County, Indiana, the damage done was very great. Mr. Kent, of Kentland, who owns several farms, says that while his individual crops should have been 50,000 bushels he would be happy to realize 10,000. He says that the loss in Kentland township will easily be 75 per cent. of the crop; but at the same time realizes that this is local, and says that the crop of the State as a whole will be immense.

THE PREVIOUS SEASON.—The persons interviewed seemed to be unanimous in the opinion that last season was very wet during the early part, and that this was followed by a very dry late summer and fall. Last winter was, as all over the country, a very severe one, while the winter before was remarkably open. The present season has been a very favorable one, the spring, however, being rather dry.

THE PREVIOUS CROP.—In fields which were worst injured I always took pains to inquire concerning the previous crop, and found considerable diversity. In two cases it had been corn, in two oats, in one flax, in one barley, and in one prairie land. In several cases also it was winter wheat which had been plowed up in April. The damage in all these fields this year was equally great.

METHOD OF WORK.—The method of work in oats is the same as in timothy and wheat, as described. The fruit-stalk is stripped of its leaves, and the head is cut off and falls to the ground, where it is usually eaten to a greater or less extent. Some farmers have taken advantage of this fact, and have turned in their swine to feed upon the fallen grain, and at the same time they undoubtedly destroy many worms and pupæ.

No marching whatever has been noticed. The worms appeared simultaneously all through the fields, and having plenty of food there was no occasion for going farther. This fact has given rise to an opinion among many farmers that this is not the Army Worm but a cut-worm that is always present in the fields. This fact also puts an effectual estoppel upon the use of the old remedies, and there seems to be no way to destroy the worms in the fields without a sacrifice of the crop.

FACTS BEARING ON NUMBER OF BROODS.—That the brood damaging oats this year was at least the second, and, in case of larval hibernation, the third, seems most probable. The injurious brood in Illinois has been usually in June, the worms pupating about the middle of the month, and the moths appearing from the 20th to the 30th of the month. In the places visited this year the worms were first noticed from the 12th to the 15th of July, and at that time most of them were of the size of a "small straw."

In one instance several empty egg-shells of Leucania were found in the vicinity of a last winter's fodder stack. They were in the fold of one of the *basal* leaves of the stalk. These, from their position, may have been laid by the first brood of moths, though from the known ovipositing habits they may equally as well have been deposited by the second moths.

In the same locality I found, by digging, the remains of two empty pupæ, undoubtedly Leucania, which certainly belonged to a previous brood.

AN ACCOMPANYING CUT-WORM.—In the fields among the Army Worms were large numbers of an accompanying cut-worm in the evident proportion of about one of the cut-worms to five Army Worms. The size of the former was about that of the latter, and the color a nearly uniform dusky brown, with transverse lateral stripes of a darker color. They transformed to slender pupæ, light brown with dorso-lateral longitudinal pinkish stripes.*

NATURAL ENEMIES.—Several larvæ of a ground beetle (probably *Calosoma scrutator*) large, black, horny, and active, were found destroying the worms at a great rate. I have been unable to breed them, the only pupa obtained dying in the box. In order to ascertain the amount of good which these larvæ do, I placed my largest specimen in a box with 15 full-grown Army Worms, after starving him for a day. In two hours I opened the box and found that he had killed every one of the worms, but had sucked dry but two.

The small white cocoons of an Ichneumonid † were found in enormous numbers, attached to the oat-stalks, in the axils of the corn leaves, upon the surface of the ground and under clods of earth. Often upon lifting a clod of earth the black loam appeared light gray from the abundance of these cocoons. They were usually found in small masses attached side by side, with a little loose silk around the mass. I saw large numbers of a large reddish-brown ant tearing these cocoons open and feeding upon the pupæ.

A secondary parasite was bred from these cocoons, which seems to be the *Mesochorus vitreus*, of Walsh.

In one instance, in a corn-field belonging to Mr. Corlett, of Sheldon, the worms were observed to be extensively infested by a Tachinid from the eggs upon the thoracic segments. Not a single worm was found in this field which did not bear one or more eggs. I have since bred from one of these larvæ a small specimen of what appears to be the common *Nemoræa leucaniæ*, of Kirkpatrick. I also observed in the act of ovipositing an Ichneumonid about 15 millimeters in length, rufous in color, with white banded antennæ, and wings not extending to the tip of the abdomen, but which I was unable to capture.

Respectfully submitted.

L. O. HOWARD.

Prof. C. V. RILEY,
Entomologist, United States Department of Agriculture.

AUGUST 7, 1881.

CORRESPONDENCE ANENT THE ARMY WORM—SPRING OF 1882.

I send you the inclosed communication from the Huntsville correspondent of the Chattanooga Times in relation to an invasion of the wheat crop in this vicinity by the Army Worm. I reconnoitered the invaders yesterday and witnessed with feelings of much sadness the devastations already wrought by them on Stevens' farm. I captured and examined some of them. It is the Army Worm described in the Agricultural Report for 1879, page 187, and the same I think that appeared here in 1861. * * *

* This proved to be *Agrotis c-nigrum*.—C. V. R.
† *Apanteles congregatus*.—C. V. R.

The insects are of different ages and it is to be apprehended that there will be successive crops of them. * * * Upon examining an oat-field yesterday, in company with Mr. White, I found multitudes of very small worms concealed under the oats sown this spring. It was about half past 3 p. m., and the sun shining. They will doubtless destroy it. Mr. Bedermann's oat patch, near Stevens' wheat-field, has been completely destroyed. Some of the larger worms in Stevens' field show that the Tachina parasite has been operating upon them. I never saw a more promising wheat crop than Stevens' before this invasion. White said to me that in the beginning of last week he would not have taken $2,000 for his own wheat crop; that he does not now expect to reap anything from it. I hear of this insect in the neighborhood of New Market and Whitesbury.—[S. D. Cabaniss, Huntsville, Ala., May 2, 1882.]

An interesting feature of the appearance of the worm in Alabama in May is contained in the following letter to Mr. Howard upon his return from the investigation made at Huntsville. The insect confounded with the Army Worm is the clover-hay worm (*Asopia costalis*):

SIR: While you were here a few days since, investigating the phenomena of the worm in wheat, I had the pleasure of an introduction and a brief conversation with you, and take, therefore, the liberty of stating to you a curious phase of the worm. Mr. J. G. Baker, living here in 1881, produced clover hay—about two tons per acre—on rich land near the corporate limits of Huntsville. The hay was cut, cured, and placed in the mow—about eight tons. He used down to about two tons, and a few days ago on taking out and delivering a load of hay, after taking it off the wagon, discovered on the floor of the wagon innumerable worms about one-half inch long, dark or greenish-brown in color. He then returned and found on examination of the hay-mow countless numbers of these worms—also what seems to be a kind of web spun in the *débris* at bottom, which had multitudes of eggs half the size of a mustard seed and black in color. This was about the first of May, and the worms have now disappeared. It seems to be a theory that these worms are bred in clover-fields, and this finding them in clover hay would seem to establish their habit of depositing on the clover-stalk in the field their eggs, in this case carrying them over to the next year and hatching then. This hay was cut about June 1, 1881, and taken out about May 1, 1882. This theory struck me as possibly inconsequential, but of enough curiosity to write you.—[L. W. Day, Huntsville, Ala., May 13, 1882.]

The Army Worm is making severe inroads upon the wheat crop and other crops here in Middle Tennessee.—[J. W. Sparks, Murfreesborough, Tenn., May 20.]

The Army Worm has commenced work. Is it safe to use London purple?—[Saint Louis, Mo., May 24, 1882.]

I send you by this day's mail, specimens of a caterpiller which is doing great damage to the wheat in this locality. I have been unable to find out how far-spread it is, but hear of it in the northern parts of this county and also in Nelson County. It attacks and eats the blade of the wheat (so far I do not see that they have hurt the heads), and I find many stalks broken off.—[H. A. K. Murray, Warren, Albemarle County, Virginia, June 8, 1882.]

Doing considerable damage to oats near Uniontown, D. C.—[L. J. Barber, June 15, 1882.]

The Army Worm is playing great havoc in this section of the State. All the late wheat is being destroyed by them wherever they have appeared. Many fields of grass that were most luxuriant a week ago, look now as if a fire had swept over them. Corn-fields, wherever they have touched, have been entirely destroyed—too late now to plant over. Clover alone seems distasteful to them. Oats, corn, orchard-grass, timothy, and wheat they delight in. We have never had them before, and don't know what may be their duration. They appeared about a week ago and are increasing in numbers most rapidly.—[Robert Beverly, The Plains, Fauquier County, Virginia, June 19, 1882.]

Inclosed find tube containing specimens of Army Worm, which has occasionally infested this country ever since its first settlement. The first serious injury was done in June, 1825, when it appeared in some wheat-fields and meadows, and after eating the heads and blades of the timothy, and partially stripping the wheat and rye of their blades and beards, with little injury to the grain, they moved disastrously upon the green corn and oats, eating down the corn and completely beheading the oats. * * * This year they appeared in the barley about the 10th of June, and have done great damage by eating off the straw just below the head, and a few days later appeared in the wheat and timothy all over the country to a very alarming extent; but just as they had got fairly to work, on the night of the 14th, the whole country between Somerville and Indianapolis was visited by very disastrous storms and floods, which seem to have caused them to suspend operations, though not to entirely disappear.—[M. B. Kerr, Aurora, Dearborn County, Indiana, June 19, 1882.]

My observation of the locality of the Army Worm laying their eggs has been this: In the early spring the moth has not the activity it has later in the season, and the greater part of the eggs are laid in the splits of broken straw and in the foldings of the leaf-sheaths, mostly covered or secreted, but in the layings of early spring I have found the eggs most abundant in the angle made by the leaf-sheath when torn from the straw at the joints of same, and *not secreted*. I do not think the hibernated moth would show its specific characteristics as much as those that have undergone their changes and lay their eggs in a higher temperature. I have noticed that a high temperature has a good deal to do with the activity of the moth of the Army Worm.

The migration of the army is not always in quest of food, though at this period, like all worms of this class, they are ravenous. There has been a migration into a field in this vicinity which I have closely watched. Before leaving a wheat-field, where there was an abundance of food, the worms showed an uneasiness similar to that shown by the silk worm before spinning its cocoon (moving the head from right to left). The first move was into the blue grass (*Poa pratensis*), and then across a traveled road into a field of corn partly plowed over with the rows in the same direction the worms were going. They ate for 10 to 15 rows every bit of corn on the *plowed ground* and but little on the unplowed. As they advanced the destruction was less and less, nearly stripping the leaves of the 30th and 40th rows, and entirely leaving the unplowed ground. These worms were of a very uniform size—full grown.

To-day I examined a few hills of corn on the boundary of their eating as they were congregating around the hills of corn in their migration. I looked there first, and at a single hill found 18 chrysalides under one small clod. I think this horde of worms left this wheat-field because it was unfit for the change from larva to chrysalis, not offering any shelter, as the ground in the wheat-field was smoothly beaten down by rain and was very hard. Where food is abundant and shelter can be found for the larvæ to undergo their changes, they will not migrate, but from either a shortness of food or unfavorable locality for chrysalides they will move. If the worms are full grown the damage will be but little compared with the migration from a shortness of food by the worms of a small size.

In the shape of the ditch, to defend a field against their incursions, there has been in this locality quite an improvement over the old undercut ditch. It is made by dragging along the ditch a ditching-gouge, such as is used in laying 3-inch tile in the angle of the ditch.

The cutting is on the side you wish to defend, this half-round cut being made by a horizontal motion, leaving a smoother surface on the half-round than can be done by undercutting with a spade, and I have never seen a worm pass the upper angle in this pattern of ditch.—[F. C. Andrus, Manchester, Scott County, Illinois, June 22, 1882.]

My brother, Alfred R. Swann, who resides on his farm in Jefferson County, Tennessee, writes me that Army Worms have appeared in vast numbers and are now destroying his grain and grass crops. The same thing occurred last season, and as this farm is a very valuable one—near one thousand acres, a large part of which is river-bottom lands—the loss involved will amount to several thousand dollars. (It is known as the Eagle Bend Farm.)—[James Swann, New York, June 30, 1882.]

ACCOUNT OF THE INVASION OF 1880 IN NEW JERSEY.

By Rev. Samuel Lockwood, Ph. D.

"Caterpillars, and that without number."—*Bible.*

It was the first day of summer, 1880. A long, parching drought had prevailed, and one felt like choking in the hot and dusty air. Although Flora's brightest month, "When June's red roses blow," the bees were almost starving in their hives, so few and poor were the flowers. The stage, on its way to the station, several miles off, picked me up at a farm-house. A strange being, hatless and shoeless, was leaning against a fence on the road side.

"That's poor Daft!" whispered the driver, in a compassionate way, as we drew near. The man seemed about thirty-five, and had a harmless, half-dazed look. Having taken a step or two into the road, he accosted us in a solemn manner, causing a momentary halt.

Daft. Have you seen the Army Worm?

Jehu. Nary a worm, Daffie!

Daft. Oh, but he's come! He's down the road about half a mile, and's committing desolation most promiscuously. There wasn't one there yesterday. But this morning, lo! a great multitude which no man can number! It's all very mysterious, the palmer worm and canker worm. His great army! Maybe that's why nobody can tell us where they come from and what becomes of them. I'd like to know if it is all past finding out.

Jehu. That's too deep for me, Daffie. G'e 'long, ponies.

Having started his horses again, the driver told me that "though feeble-minded elsewise, Daft was real powerful on Scripter."

I had that morning at an early hour been watching the conduct of an army of *Leucania unipuncta*, the very one to which Daffie referred so mysteriously. In truth, actuated by the vastness of this invasion of the Army Worm, I was then on a season's observations, which it is proposed to give with some fullness of detail; and perhaps we may thus true answer make to the wise questions of that innocent.

The army above mentioned had just made complete havoc of a clover-field. They were bred from eggs laid in a low-lying, last year's rye-field adjoining. After but partially eating the grass in this old field, it was abandoned for the more succulent and tender clover and grass in the next field. The very unusual heat and drought had been too much for the young worms, having rendered too tough the grass in the field where they were hatched.

In the new field the clover and the grass in its shade were much more comestible. This field was completely devoured—not a spear of grass or leaf of clover escaped the invaders. Nothing but naked clover-stalks with empty heads remained—even the headlands were thoroughly cleaned up. A low but distinct and unpleasant crinkling sound accompanied the feeding. As if actuated by one impulse the whole army made straight for a wheat field across the highway. The plowing of a trench on the far side of the road intercepted their march. Two men with spades cut a clean perpendicular face on the side of the furrow next the wheat and a series of little pit-falls in the trench at intervals of about 50 feet. This completed the trap. The caterpillars, wearied with useless efforts to climb the straight side of the trench, would crawl along until they fell into the little pits. Myriads of ants beset them, sucking out their juices, which with the heat of the sun soon destroyed them. They cannot endure direct sunlight but are essentially night-feeders.

If uninterrupted, their march to the new feeding grounds would have been accomplished ere the sun was well up.

The time in which the Army Worm did its chief mischief in Monmouth County, New Jersey, was from about the close of May to about the 20th of June. The first observation of real mischief being done was May 28. During the above time my duties led me to ride over the entire country on official business with the teachers and school-officers. Thus opportunities were afforded for observation and inquiry such as a naturalist could not afford to neglect. I had supposed the aliment of these insects to be restricted to the *Gramineæ*, that is, the grasses proper and the grains and Indian corn. Hence, surprised at the thoroughness with which they had eaten up that field of clover on the spot, I took it for an original observation of an exceptional habit; but on looking into the Riley reports, I found similar facts on record. I soon ceased to regard this habit as at all exceptional; for, so far as Monmouth was concerned in 1880, clover-eating by the Army Worm was the rule and not the exception. In fact I could not learn of one instance of their presence in which the clover escaped. The following from a letter by a teacher is to the point:

"On the farm of Charles Allgor, at New Bedford, in passing from his wheat-field to his oat-field, the worms had to cross a strip of sward composed of timothy and red clover, of three or four years' standing. They took everything clean. They also ate the young clover in the bottom of the wheat-field, killing it entirely. In a mixed sward of George Newman's, the teacher, they ate the clover as well as the grasses, leaving nothing but the stalks. They also ate the clover on the farm of Albert King, at Green Grove. They did not make a specialty of clover, but they ate it without being starved to it. They ate both the clover and timothy in a mixed sward of James Allgor's. They ate Mr. Allen's oat-field, then went over to his sward of grass and clover and finished that off, too."

Other correspondence might be cited to the same effect, but I have none which states the facts so concisely as the above. Some of the farms here mentioned are miles apart. But it will appear further on that when forced into straits for food this Army Worm is almost omnivorous.

With no special call to examine his young grass-fields, the farmer sometimes got his first alarm at sight of the disappearing clover. In fact, wherever the worms appeared in force the grasses, clover, and Indian corn were completely destroyed. A friend lost forty acres of newly-sown grass, with a large part of the old meadows; a very serious score here for one man, as with us "Hay is King." Let me instance a forty-acre wheat-field of his of which the worms took possession. The wheat when harvested proved a good yield, for it had got out of milk when the army made its inroad. The straw was not hurt, although the worms had climbed every stem up to the head; but straw and ear were nearly ripe. It was different, however, with the low and late-grown stools. These they crept up and ate through the thin green neck of the plant, cutting off the nubbin-ears which fell and thickly covered the ground. If the outside of the straw was not too hard, the worm would then literally skin it, eating downwards. They would eat these nubbin-heads occasionally before cutting them off; but this was only when they proved to be soft; that is, those ears whose growth had been backward.

In this wheat-field the young grass and clover were all eaten up and the head-lands cleared off. Every weed, too, was cleaned up. Even that bitter nuisance, the Rag-weed (*Ambrosia artemisiæfolia*), was all devoured. With us after harvest the Rag-weed takes possession of the soil; but as this weed makes its appearance in summer, the spring timothy and clover get the start and keep this weed under. The fall succeeding the harvest above presented the singular spectacle of a stubble-field without a weed. It was sheer nakedness itself. On another farm, having consumed the grass, the worms took possession of a strawberry-field, eating both leaves and the unripe fruit. Riley gives an instance in which, when driven into straits, these caterpillars ate an onion patch. We must then conclude that the larva of *Leucania unipuncta* is well nigh omnivorous. Doubtless when its food is tender and in no stint, like the Lord Mayor's fool, it knows what is good and is much more dainty.

The number of worms in that forty-acre field was simply fearful. In the parlance of the spectators there were "millions and millions." The squirming mass and the crinkling sound of their feeding were especially repulsive. But few dared to enter the field. In truth, strong men turned pale from nausea, so loathsome was the sight. It really seemed that nature was smitten with a plague of crawling vermin.

What governs the direction of travel of these worms? Do they smell the new food from a distance? I think they do, for they cross naked roads with unerring directness to the object sought. The great army in that wheat-field having finished their havoc, divided into two parts: the one left on one side and entered a timothy-field—the other left the foraged land and marched straight across the road and took possession of a corn-field. Having ruined the timothy and the corn, the great army disappeared, as was remarked, "As if by magic!" But the trick was very simple; they had entered the ground to assume the pupa state. The notion prevails that the worms move for a certain point of the compass. Here the phrase was "They moved towards the sea," that is, south; but in another part of the county the movement seemed north.

Many years ago I saw an army moving west, but the Greeley precept was rife at that time. I attach no importance to the above, my belief being that the insect, attracted by scent, in which perhaps the wind plays a part, moves simply in the direction of food. A point of greater consequence is the *time* of the first movement. From a number of observations I believe the time is about seven days after the hatching.* When first hatched they are so small that the damage they effect is slow, and their feeding is restricted to the tender parts of the grass. After this comes the first march when they are ravenous enough to clean up as they go.

That was a triumph of painstaking patience and admirable skill when Riley cleared up the mystery of the origin of the Army Worm. Nor can I forget my own delight when, in his laboratory at Saint Louis in June, 1876, he showed me the live insects which he had raised from the larvæ; nay, more, right before my eyes was the mother *Leucania unipuncta* laying her eggs in the axils of dry stubble and green grass. For science that was a grand discovery. Still more's the pity how few farmers make of it "a seigne of vantage." Nay, to some good husbandmen do we not seem in these searchings to tamper profanely:

> And take upon's the mystery of things,
> As if we were God's spies.

These appearings are regarded as almost miraculous. Says the perplexed rustic: "They come in great armies—and all of a sudden—and as suddenly disappear." Or, as Dallie said, "There wasn't one there yesterday, but this morning, lo! a great multitude which no man can number." Friends, this is a delusion. They were there yesterday and several days. They do not come suddenly. You do not observe their coming, you only see them when they are on you in great numbers. Watched from the eggs their life-career is that of other caterpillars. The following should enable one to observe them at their starting point and to stamp them out at the beginning.

First. It is important to know *when* to look for the laying of the eggs. Of course much depends on the nature of the season. With us it is usually the first week in June, but in 1880, for reasons already mentioned, the laying was not later than the 20th of May.

Second. Where should we look for them? Thanks to Riley, we know how the eggs look and the part of the plant where they are laid. The farmer, however, needs, if possible, to know just where on his farm he should look for the infested plants. I think generally the grain-fields are preferred by the moth when seeking a nesting place for her eggs. But if the weather be favorable, and the young clover and grass in the best condition, she will also be found laying in the young grass of last fall's stubble-field and in old meadows. In this case we should look for the highest or closest grass—that growing in moist places, and notably those little hummocks or tussocks caused by the droppings of cattle. If heat or dryness affect their food they will select the grain-fields as affording more succulent food, besides better shelter and shade. Let me instance some careful observations made on four farms, three of which were near together, but the last one to be mentioned was about two miles away. On one was a wheat-field, which covered the site from which certain stables had been moved the year before. Another part of the field lay low, and received the "wash" of the higher ground. On these places the wheat grew thick and high; in fact, too luxuriantly, for it became badly "lodged." These two spots were shady, and the

*It is in reality generally somewhat later.—C. V. R.

food was sweet and tender. There were no other such spots in the field, and these, and only these, were chosen by the moths in which to lay their eggs.

Doubtless very many moths selected these spots, for here the worms were bred in great numbers. These spots were soon eaten off clean—clover, and grass, and wheat leaves, and heads—for in these places the wheat ears were still green and tender. From these nesting spots they spread, a voracious army, over the whole field, clearing up everything that had not become too hard to eat.

On another farm close by was a field of wheat which had received peculiar tillage. It belonged to a Mr. Bodee, a very intelligent amateur farmer, whose clear observations have been of substantial service to me. He holds that wheat should not be crowded, and should be worked with a cultivator, much as we do corn; that room and encouragement should be given each plant to enlarge itself by stoles; that one well-stoloned plant is better than several plants forced to occupy the same surface of ground. In sowing, the field was drilled only one way, and every third drill was left seedless; and in cultivating, some of the teeth of the implement were taken out, so that it could straddle the double rows. In this way the field was gone over, both in the autumn and in the spring. There were but three little spots where the wheat had lodged, all of which were breeding-places for the worms, from which, after eating them off, they spread over the field, but seemed to be comparatively harmless; for the tillage mentioned let in the sunlight and quickened the ripening of the grain. It was noticed here that the birds, having more wing-room, were quite busy feeding on and carrying off the worms, a fact not observed by us in any other wheat-field. Perhaps the cultivator had mellowed the ground, for the worms, during the hot sunshine, buried themselves in the cultivated space and were easily unearthed by the birds.

In a field on another farm the wheat was somewhat thin; but on a spot where a compost had lain the wheat was rank and thick. There the worms bred and, after devouring their nesting place, they spread over the field.

The fourth field of which the particular facts must be given, is that forty-acre wheat-field, already instanced. The sowing took at least twice as much seed per acre as was used by Mr. Bodee's method. It was drilled in one direction, and then drilled across at right angles. This secured a crowded growth. During the summer preceding the autumn sowing the field had been used by a horse dealer to pasture a large drove of horses. Of course their ordure fell everywhere; but in many places where the animals had stood in groups the droppings had fallen in quantity. Here I must recall an acquaintance once had with a farmer's boy, named Ned. He had a way at time of wheat-sowing of putting a shovelful of manure and an extra dropping of seed in a few spots in the field to make what he was pleased to call "King hills." And it was easy telling where the lad and his shovel had been, for Ned's "King hills" always outranked the rest of the field. And it was similarly with that big wheat-field. It was a splendid sight, the close dense growth, and high over all, in many places, those stately "King hills" were conspicuous. Now comes the notable fact; every one of these spots was chosen as the nesting place of myriads of the mother moths, for the number of eggs laid in them was enormous. These spots were to the Army Worms shelter, shade, and food, but so crowded was each of these larval communities that they soon ate themselves out of house and home. Then came an immense dispersion. From every "King hill" went forth a hungry band into that grand foraging ground. The wheat, standing so close, had by its shade kept the undergrowth protected from the drought; and now it sheltered these marauders from the sun. It was but a few days before that these foraging bands, by their spreading, had all met and made up a vast famished army, which, driven into straits, must now devour every comestible thing or starve. The observed occupancy of the field was seven days; that is, from the time of the dispersion of the foraging army to the time when it left. It was quite common to hear it said that a certain field was eaten up in a day. But such people "take no note of time."

Leucania, the parent of the Army Worm, ranks very respectably among the Lepidoptera. She is one of the owlet moths, and her owlish capacity for natural selection impresses me profoundly.

> Nature is fine in love: and where it's fine
> It sends some precious instance of itself
> After the thing it loves.

I find so much precision in insect wisdom, such a knowing method, even in the propagation frenzy. And I think Leucania's conduct is in point. True, there is no bird-like brooding over her trust. Let us get out of the laboratory and watch her where, not hampered by the inquisitorial restrictions of the breeding-cage, she has Nature's airy freedom, and

> The world is all before them, whence to choose
> Their nesting place.

And this maternal moth shows such good mothering in her choice. The knowledge of this nicety of her selection of a nidus is of great economical value. Compare her restriction with the flitting habit of her queenly relative, the Hawk-moth—*Macrosila quinquemaculata*—parent of the great potato worm. Almost with a shudder one remembers that terrible invasion of Monmouth, when the potato-fields were ruined as if by fire, and the wagon wheels reeked with green dripping gore as they entered our villages. This moth deposits her eggs on the underside of the potato leaf, but only one or two, or at most a very few, on each plant; hence the distribution is pretty uniform over the entire field.

Though it may seem above that the parent of the Army Worm has fair intelligence, we may not think so well of her larval offspring. That beautiful lawn of Hollywood, at Long Branch, was invaded by them. The emerald sward was swept as if burnt. When any of the worms came against a tree they went up it, passed over the crotch, then descended at the other side. Twelve or thirteen years ago a corner of our country was visited by the Army Worm in large numbers. Having stripped one field they marched for the next, but were intercepted by a small, running stream. There is no "turn back" to this singular worm. On came this great automatic army—no halt—until, crowded forward, a compacted mass was urged on to the water to serve as a living pontoon, over which the army passed and took possession of the new foraging ground. This crossing of running water has been noticed by Mr. Riley.

Monmouth is an old county, and the farms generally have been much reduced in size by frequent divisions. Grain and grass fields run from ten acres to forty, but the latter figure is very high. As we have described, each field, from a few nesting spots, would originate an army. Some of these infested fields were miles apart, the intervening territory being exempt. I got returns of twenty of these armies in one township. There surely could not be less than one hundred in the county. They seemed to have a penchant for the best farms.

LET US RECAPITULATE.

1. We can localize the breeding places. The mother moth selects the thick and shady spots in the grain fields and meadows as the right places in which to lay her eggs, thus securing for the larvæ shelter and tender food.

2. An army is made up of bands, each band having its own breeding spot, and these spots are centers of dissemination. When these nesting spots are eaten off the bands spread, traveling in the direction of food, thus uniting, when, so to speak, the clan relation is lost. They now form one hungry and marauding army, set in one course and impelled by one impulse. It is at this point of their career that they are generally first noticed, and the averment is made, "They have come all of a sudden."

3. A thin tillage is adverse to the worms. It makes the conditions of life harder for them, less shade, more heat, earlier ripening, and quicker toughening of grass and grain, and greater freedom for the birds.

WHAT SHOULD BE DONE.

4. Till uniformly, and not too close. You may get less wheat, but you will get better, and the worms will fare worse.

5. Try to find out where the caterpillar originates. Beginning early in May, watch the thick spots and the damp places in meadow and grain. This inspection is especially called for if the winter has been mild and the spring is warm. As described by Riley, the eggs are very small and round when first laid, of a glistening white, but becoming yellowish. They are laid in stringy groups containing from five to twenty eggs. They should be looked for in and near the axils of the leaves; that is, in the spout-shaped parts of the blade, near the stem. In this hollow of the leaf the eggs are glued, and sometimes the two edges of the leaf are so drawn together that the eggs look like a white streak. Should you find the eggs, if in quantity, it might not be practicable to attempt collecting them, but you have found a breeding spot, and it is now possible, and without injury to the grain or grass at this early stage, to extinguish the worm with a weak solution of London purple or Paris green. If the spots are small they could be cut out with a sickle and fed to stock. If the eggs are hatched the crinkling sound made when feeding, which is in the early evening and just before the morning dawn, will to a good ear betray the presence of the larvæ.

Our Army Worm is *Leucania unipuncta*, for there are other caterpillars which are wrongly so called. The moth is 45^{mm}, or about 1¾ inches in expanse of wing, and 24^{mm}, or about ¾ inch in length of body. The color is very plain, being a reddish-brown or cinnamon, with a double white spot or blotch on each front wing.

The insect is with us the whole year. In the pupa state, in the ground or under stones and other bodies, they pass a large part of the year, including the winter, while many perfect moths hibernate under the shelter of some concealing object. In the spring the mother moth devotes herself to egg-laying, which done, a day or two suffices at most, when she dies of sheer exhaustion. The appearance of the spotted

Leucania in large armies, as a rule, can only occur after intervals of several years. The weather conditions which caused their appearance in New Jersey in 1880, in such amazing numbers, were very remarkable. The winter had been so exceptionally mild that the moths came safely through hibernation and in large numbers. A rainless May, and unusually warm, brought in, in effect, a premature summer. Early potatoes failed; corn had to be replanted; rye was in ear in April; wheat began heading by the 12th of May, and such was the heat that the filling of the ears and the getting out of milk followed fast. Wheat-cutting began June 18, and at the end of the month the harvest generally was over, nearly three weeks earlier than usual. And not only was *Leucania unipuncta* affected by the weather conditions of that remarkable year, but the insect tribe generally.

NOTES.

1. Since the foregoing was written I have seen "abstract" of a paper on *Leucania unipuncta*, read by Prof. C. V. Riley at the Boston meeting of the A. A. A. S., August, 1880. He says: "In the latitude of Saint Louis there are two, sometimes three, generations in a year, and, perhaps, even four; and farther south a succession of generations, scarcely interrupted during mild winters. Probably in New England there are two generations, the second one being 'usually unnoticed,' and existing through the autumn, winter, and early spring months.

"It is an established fact that the species hibernates both as larva and as moth, with strong circumstantial evidence that it also hibernates, particularly northward, as a chrysalis; but we have no evidence that it can hibernate in the egg.

"Excessive injury may result from natural local increase, or from moths flying in great numbers from other localities, and concentrating in particular fields. Dry seasons are favorable to the multiplication of the insect."

SCALE INSECTS OF THE ORANGE.

REMEDIES AND THEIR APPLICATION.

By H. G. HUBBARD, SPECIAL AGENT.

CHARACTERIZATION OF THE SPECIES.

In devising practicable remedies for Scale insects, the first factor of importance is seen to be that there are several kinds of these insects which yield to treatment in very different degrees. Without entering upon the subject of classification, which has already been fully treated in reports of the Department of Agriculture, we may, for the purposes of the present article, divide those that infest trees of the orange family into two groups—the naked Coccidæ (*Lecaninæ*), and those which are protected by a horny scale (*Diaspinæ*). The former give comparatively little trouble; their colonies rarely increase sufficiently to endanger the life of a tree, and are invariably checked—often exterminated—by their parasites. Moreover, their unprotected bodies are vulnerable and exposed to the action of strong lye or soap solutions and other insecticides.

The Scale-armored *Diaspinæ* are much more destructive in their ravages, and their astonishing powers of reproduction frequently enable them to outstrip their natural enemies. Owing to their protective covering they are but little affected by most of the washes and insecticides in general use. Of this group three species are known to me, and are universally distributed in orange groves throughout Southeastern Florida.

Mytilaspis Gloverii (Packard), the common "Long Scale," or "Oyster-shell Scale," is familiar to orange-growers as a dark-brown, or yellowish particle, very elongate in form, which infests the twigs and branches, appearing finally upon the leaves, and, more rarely, upon the main trunk of the tree.

Mytilaspis citricola (Packard), to which the name "Purple Scale" may be given, is somewhat larger than the preceding, which it resembles in general form, and with which it is commonly confounded. It is, however, usually dark-purple in color, individual scales varying to red-brown. Like the Long Scale it is found upon the twigs and branches, and it is apt to infest the lemon, citron, and those varieties of orange which have large oil cells (Tangierine, &c.)

Parlatoria Pergandii, Comstock, is a small thin scale, nearly circular in outline. In color it so closely resembles the bark that it very often escapes notice. In fact, many persons whose groves are suffering from the attacks of this scale are unaware of its presence. It infests by preference the trunk and larger branches, and to these it generally confines itself until every portion of their surface is thickly coated and the young bark-lice can no longer find places to plant themselves. It is also frequently seen upon the fruit. The young often form their scales underneath or over the mother, and are found piled upon one another, in a manner never seen in the other scales. From their resemblance to a coating of fine chaff, or bran, upon the trunk of the tree, I have called this the "Chaff Scale." These three scales are so universally distributed that it is safe to say no bearing orange tree exists in Southern and Middle Florida upon which one or the other cannot be found.

The Long Scale (*M. Gloverii*) is the most destructive, while it is the most readily destroyed. The Purple Scale (*M. citricola*) is in my experience rarer, although not less injurious than the Long Scale, to the trees which it infests. It is somewhat more difficult to kill than the latter. The Chaff Scale (*P. Pergandii*) is hardly less common than the Long Scale and is very frequently associated with it. Of the three it is decidedly the most difficult to exterminate, owing, in part at least, to its habit of piling or lapping one over the other. Except upon very young trees it seldom does permanent injury, and is much less to be feared than the other two species. Its thinner scale renders it liable to the attacks of enemies to a much greater extent than the Mytilaspis Scales, and they often cause its complete disappearance from a tree.

The life-history of these Scale insects has been so recently set forth by Professor Comstock (Department of Agriculture, Report 1880,) that a full recapitulation of the subject here is unnecessary. In treating of remedies three periods in the development of the insect require to be noticed.

The PERIOD OF MIGRATION, during which the newly-hatched larvæ are possessed of legs, and wander over the tree, lasts but a few hours, or at most one or two days, after which the young coccids fix themselves upon the bark and begin to suck the juices of the plant.

The PERIOD OF GROWTH, during which the insect loses its legs, undergoes several molts, and excretes a scale, varies in duration according to the season of the year, from one to two months, and is lengthened by cool, and shortened by warm, weather.

The PERIOD OF INCUBATION, during which the eggs are deposited and hatched under the fully-formed scales, varies greatly in duration, depending upon the season and temperature. In February, with uninterrupted warm weather, the females of the Long Scale (*M. Gloverii*) continue to deposit their eggs during sixteen or eighteen days. The eggs hatch in summer in a week or ten days. In winter the time is extended indefinitely by cold, which is, however, never of sufficiently long continuance to cause an entire suspension of the process. The young, after hatching, remain many days under the parent scale, if the weather is unfavorable.

Up to the time of the first molt the bark-lice are easily destroyed by insecticides of moderate strength, but during the remainder of their existence they are protected by the scale, a horny covering, excreted by the insect, and entirely covering its body above. The under layer, or ventral scale, is somewhat thinner, and, although perhaps a separate piece, is firmly united to the upper scale at the edges, so that the latter appears to be turned under at the sides. In *Mytilaspis* the ventral scale forms flanges along the sides, which do not quite meet along the center line, but in *Parlatoria* it forms an unbroken shield, which entirely separates the body of the insect from contact with the bark. This more perfect protection from below renders the Chaff Scale more difficult to destroy by means of external applications. The scale is permanently fastened upon the tree, and so closely molded to its surface that the pores of the bark, or the stomata of the leaf, are seen plainly stamped upon it when removed.

As the scale, like the shell of the snail, is formed by successive additions, and keeps pace in its growth with that of the body of the insect within, its vulnerable point is the growing end, and there are times during its formation when the posterior extremity of the insect projects slightly beyond it and becomes exposed to the action of penetrating liquids. This is particularly the case at the critical periods when the coccid sheds its skin. But when the scale is fully completed and tightly sealed at all points, no insect is more difficult to reach and to destroy.

The substance of which the upper scale is composed is impervious to most liquids, and is not soluble in acid or alkaline solutions strong enough to injure the plant. It resists the action of oils and of bisulphide of carbon, an almost universal solvent. Many insecticides are therefore inoperative, and all insoluble substances, such as sulphur, &c., are clearly useless, as they do not reach the eggs or mature insects. The thinner ventral scale is not impervious to the more volatile oils or to alcoholic solutions, some of which reach and kill the insect by penetration through the bark.

From the foregoing outline of their structure and history it will be seen that for a brief period only in their development these insects are easily assailable. During the period of migration the tender young may be destroyed by solutions of whale oil soap, lye, &c., sprayed over the trees; and were the eggs hatched simultaneously and the broods clearly defined, as with many other insects, their extermination would be a matter of no difficulty. This is, however, not the case; the open winters in Florida permit continuous breeding throughout the year, and at all seasons scales in every stage of development are found upon the trees. There are, however, times when the number of migrating young reaches a maximum, and the application of remedies then proves particularly effective.

Three such periods occur: the first in spring, usually in March, but sometimes extending into April; the second in June or July; the third in September or October. During the winter months, if the season is a mild one, there is a fourth very irregular brood beginning in January and continuing through this and the following month. The spring brood that follows is greatly confused. In cold and rainy winters, like that of 1880–'81, the hatching process is retarded, and the appearance of the larvæ on the return of warm weather is more nearly simultaneous than in ordinary seasons.

The eggs of coccids, as is the case with all insects, have much greater vitality than the insects themselves. Many substances which destroy the living insects have no effect upon their eggs. The periods in which the majority of the scales are filled with eggs are therefore those in which the application of remedies is likely to prove least effective, and it becomes important to know the seasons at which these maxima occur. They immediately precede the appearance in numbers of the migrating larvæ, and may be stated to include generally the months of February, May, and August, and the winter months from November to January.

The above data concern more particularly the common Long Scale (*M. Gloverii*). The broods of Chaff Scale (*P. Pergandii*) have not been as carefully studied at all seasons, and may be found to have somewhat different periods. During the past winter (1881–'82) I have found this scale to be about two weeks in advance of the Long Scale. The Purple Scale (*M. citriocla*) has not been continuously observed, but seems to have the same brood periods as Long Scale.

THE WORK OF ENEMIES AND PARASITES.

Numerous enemies prey upon bark-lice in all their stages, and always greatly reduce their numbers. Besides occasional enemies, such as the sucking bugs, and other predatory insects, which are general feeders, there are others which live almost or quite exclusively upon the Coccidæ. Some of these confine their attacks to particular kinds of Scale insects. Several very common beetles of the family *Coccinellidæ*, the "lady bugs" are useful destroyers of bark-lice. One of the smallest of this family, *Hyperaspidius coccidivorus*, is found to colonize upon the trunks of orange trees, thickly infested with Chaff Scale, and entirely free them of the pest. The young of a lace-wing fly (*Chrysopa*) feeds upon the bark-lice in all stages, and frequently makes its case of scales torn from the bark, and often still containing living occupants. The orange basket-worm (*Psyche confederata* Gr. & Rob.) has the same habit, and the caterpillars of at least two moths are bark-louse eaters. One of these (an unknown Tineid) inhabits silken galleries, which it covers with half-eaten fragments of scales, and performs such efficient service that every scale in its path is removed from the bark and suspended in the investing web.

The most important external enemies of the Scale insect are certain mites, which are omnipresent upon trees infested with Scale, and which feed upon the eggs and young lice. They breed rapidly and lurk in great numbers under old deserted scales, where their eggs are extremely well protected from the action of insecticides. For this reason, when an effective application has been made by spraying infested trees, the trunks should not be scraped for some time after, but the dead scales should be allowed to remain upon the bark for several weeks, in order that the mites which they harbor may be given time to complete the work of the remedy used. In this they may be confidently relied upon as powerful auxiliaries. When large numbers of the scales have been killed by spraying with oils, &c., the mites are often observed to increase suddenly, as they are much less affected by the application than the Scale insects themselves. It seems probable that they feed upon the dead and dying coccids as well as upon the living, and the loosening of the scales and abundance of food at such times stimulates them to rapid increase. They soon swarm in such numbers as completely to exterminate the remnant of the coccids left alive by the wash.

Of all its enemies, the most efficient destroyers of the Scale insect are its hymenopterous parasites. These are minute four-winged flies, which bore through the scale and deposit within a single egg. The little grub hatching from this egg feeds upon and destroys the occupant of the scale and completes its own transformations in its place. When fully adult the parasite emerges through a round hole eaten in the shell, leaving behind an empty domicile to serve as a shelter for the mites.

The numerous species of these parasites, although not invariably confined in each case to a single species of bark-louse, have distinct methods of attack from which they do not vary. Thus the Long and the Purple Scales are parasitized at about the time of impregnation of the females, or when they are not more than one-half their adult size and the young hymenopteron is developed entirely within the body of the coccid. The skin of the latter hardens when life is extinct and doubly protects the parasite during the latter part of its larval and in its pupa stage. The parasite of the Chaff Scale makes its attack at a later stage, often when the scale is full of eggs and its larva does not enter the body of the coccid, but feeds upon it and the eggs indiscriminately, occasionally devouring the eggs alone and leaving the mother coccid untouched. Its pupa is formed naked within the scale and has only such protection as this affords the coccid and its eggs. In individual numbers these hymenopterous parasites abound to such an extent that rarely less than 25 per cent. and often more than 75 per cent. of the scales are attacked by them, and the work of destruction accomplished through their agency alone equals if it does not excel that of all other enemies combined. Doubtless without their aid the culture of the orange and related trees would, in Florida at least, become impracticable.

Ordinarily the various checks upon their increase are sufficient to prevent the spreading of bark-lice to an injurious extent, but at times they increase so rapidly that they entirely outstrip their enemies, and all parts of the plant become thickly coated with scales. The growth of the tree is then checked, the infested twigs and branches die, and often the entire upper portion of the tree is lost. The roots and trunk, however, survive, and the tree endeavors to repair the injury by throwing out shoots from below. When a tree reaches this impoverished condition, matters usually begin to mend. The bark-lice upon the dead or dying branches perish by starvation, the parasites reassert their sway, and slowly the tree regains its health and vigor, but seldom its pristine beauty.

The causes which excite such sudden outbursts of the pest are not clearly known, but it may be conjectured that peculiar conditions of the sap are especially favorable to the development of Scale insects, and, perhaps, affect the reproductive function, stimulating the females to greater productiveness. Experiments upon this point have not been conclusive, but observations show that individual females vary considerably in the number of eggs deposited, and that they attain their maximum size and productiveness when in the full tide of increase upon infested trees. There is a wide-spread and apparently well-founded opinion that vigorous trees are in little danger from attacks, but if from any cause a tree becomes enfeebled, its investment is only a question of time. Many persons refuse to apply insecticides, relying upon their ability to keep their trees vigorous, or to restore them when out of condition by the liberal use of fertilizers. It cannot be denied that this course of treatment is very often successful, but over-stimulation by means of fertilizers is apt to defeat its object, and numerous failures from unknown causes might be recorded.

The utter inadequacy of nearly all the washes hitherto used has led many fruit-growers to despair of obtaining permanent benefit from the application of remedies, and a common practice has been to cut back badly-infested trees, leaving only the main trunks, or in the case of well-grown trees, a portion of the main branches, and to scrub thoroughly every part of these with solutions of soap or lye, using a stiff brush, and as far as possible removing every scale. This, however, involves great care and considerable labor, and the complete extermination of the pest is rarely accomplished in this way. The loss of branches is indeed replaced with extraordinary rapidity, but the Scale insects re-appear as if by magic, and in one or two years become as bad as before.

The opinion is often expressed that the tree will "throw off the scales," or that they will "disappear in time at the ends of the branches." The facts upon which this belief is founded are simply that the young lice, when the branches become crowded, wander off and on to new growth; their course is, therefore, naturally upward and outward. When the advancing army reaches the ultimate branches, the insects crowd upon the smaller twigs and leaves, killing them rapidly and involving themselves in the common destruction. The tide of scales is then checked, while the enemies thrive and multiply, feeding upon the dead and starving coccids. There then occurs one of those sudden oscillations of the balance which are familiar enough to entomologists; the unseen enemies increase and the scales visibly diminish. The tree meantime has rest and time to recover its vigor, and the trouble for the time being is over. It is, however, a mistake to suppose that all the scales are disposed of, or that this is the invariable termination of the pest. There are not unfrequently inundations of the destroyer which involve entire orchards in their resistless course, and remain for years, blasting successive crops of fruit and permanently destroying the symmetry of the trees.

Very young orange trees seldom exhibit these phenomena of the disappearance of scale with little injury to the trees. Their tops being small, and the branches few and short, they are usually entirely overrun in a single season, and, if not attended to, sustain irreparable injury, resulting, in the case of budded trees, in the destruction of the budded portion. For obvious reasons in young groves of budded trees the cutting-back process is not often resorted to, and the only alternative has been to go over the trees with a brush or swab, using cleansing soap or lye solutions, and removing by hand as far as possible all the scales. In this way young trees may be for a time relieved, but while the enemies and parasites are nearly exterminated a sufficient number of scales to restock the plant inevitably escape detection. The bark is at the same time cleared of obstructions to their spread, and the operation has to be repeated at intervals of three or four months. By this laborious and expensive process many groves are brought through the critical period of adolescence and reach the bearing age, but the seeds of mischief remain a constant menace for the future.

In the preceding pages I have endeavored to show, from a brief examination of their history and structure, that Scale insects become less vulnerable as they grow older; that during the earlier portion of their existence, which I have termed the migratory age, they are easily assailable, and although this age is of short duration, and not strictly limited to any season of the year, the months of March, June, and September, which mark the appearance of successive broods, are those in which the application of remedies gives the greatest advantage. Various methods of treatment have been reviewed and their advantages and disadvantages discussed. Finally, the work of enemies and parasites has been indicated sufficiently at least to show their importance and the danger of interfering with their operations by means of half remedies.

REMEDIES—THE ACTION OF INSECTICIDES.

It remains to examine the action of insecticides and to give the results of experiments made during the past season, 1881–'82, under the direction of Professor Riley, the Entomologist of the Department of Agriculture.

From what has been said of the nature and structure of the horny covering that protects the three Diaspinous scales, with which we are chiefly concerned, it will be seen that application of solid substances are not likely to prove practicable, and that for cheap and effective remedies we must look to penetrating liquids. The cost of alcohol renders its extensive use as a solvent impracticable. The volatile oils are as a rule powerful insecticides, but as they reach the insect from beneath by penetrating the bark of the tree, and are all to a greater or less degree injurious to vegetation, their use undiluted can in no case be recommended. Some of the light oils, *e. g.*, naphtha, turpentine, &c., are extremely hazardous remedies, and experiments with them are known to have resulted in the destruction of the orange trees upon which they were applied.

KEROSENE.—The value of this substance as an insecticide is too well known to need further testimony here. Of all the light oils which I have tried, or of which I have any knowledge, it is the least injurious to plants of the Citrus family. Refined kerosene, separated from the deadly naphtha oils, has frequently been used undiluted, without injury.

Crude petroleum is said to destroy the bark, and even the refined oil, if applied in the hot sunshine, completely defoliates the tree. Applied in the shade, at sunset, or in cloudy weather I have never known any serious injury to result from its moderate use. The tree invariably loses the old and devitalized leaves, but young and vigorous growth, especially tender sprouts and budding leaves, are entirely unharmed by it. Nevertheless, so many cases of loss are reported that its use, undiluted, must be considered dangerous. In very fine spray, and with proper precautions, pure kerosene can probably be used with impunity, but all attempts to apply it in small quantities with other liquids, by dashing them together, should be discouraged as dangerous, or at best unsatisfactory, since it is impossible in this way to insure an even distribution of the oil to all parts of the plant.

There is, however, a safe and ready method of diluting kerosene and similar oils, and rendering them miscible with water. This method, as has been indicated by Prof. C. V. Riley (Scientific American of October 16, 1880), is to emulsify the oil with milk.

The want of success which has attended former experiments with emulsions of kerosene and milk (see Department Report, 1880, page 288) is due solely to failure in properly combining the ingredients, and the consequent use of an imperfect or unstable emulsion. The process of forming a perfectly stable emulsion of kerosene and milk is comparable to that of ordinary butter making, and is as follows: The oil and milk in any desired proportions are poured together and very violently dashed or churned for a period of time, varying with the temperature, from fifteen to forty-five minutes. The churning, however, requires to be much more violent than can be effected with an ordinary butter-churn.

The Aquapult force pump, which is also the most effective instrument I have seen for spraying orange trees, may be satisfactorily used for this purpose where moderate quantities only are required. The pump should be inserted in a pail or tub containing the liquids, which are then forced into union by continuous pumping back into the same receptacle through the flexible hose and spray-nozzle. After passing once or twice through this pump the liquids unite and form a creamy emulsion, in which finely divided particles of oil can plainly be detected. This is as far as the process can be carried by stirring or by dashing in an ordinary churn; the product at this point will not bear diluting with water and separates or rises at once to the surface. On continued churning through the pump the liquid finally curdles and suddenly thickens to form a white and glistening butter, perfectly homogeneous in texture, and stable.

The whole amount of both ingredients solidify together, and there is no whey or other residue; if, however, the quantity of the mixture is greater than can be kept in constant agitation, a portion of the oil is apt to separate at the moment of emulsification and will require the addition of a few ounces of milk and further churning for its reduction.

This kerosene butter mixes readily in water, care being taken to thin it first with a small quantity of the liquid. The time required to "bring the butter" varies with the temperature. At 60° F. it is half to three quarters of an hour; at 75°, fifteen minutes, and the process may be still further facilitated by heating the milk up to, but not past, the boiling point. Either fresh or sour milk may be used, and the latter is even preferable.

The presence of kerosene does not prevent or hinder the fermentation of the milk; on standing a day or two the milk curdles, and although there is no separation of the oil the emulsion thickens and hardens and requires to be stirred, but not churned, until it regains its former smoothness.

If sour milk is used no further fermentation takes place, and if not exposed to the air the kerosene butter can be kept unchanged for any length of time. Exposure to the air not only permits the evaporation of the oil but also of the water necessary to hold the oil in emulsion; the kerosene slowly separates as the emulsion dries up and hardens.

Kerosene emulsions may be made of almost any strength; the quantity of milk required to hold the oil does not exceed one-tenth. But emulsions containing over 80 per cent. of the oil have too light a specific gravity and are not readily held in suspension in water. On the other hand, in the process of emulsification, kerosene loses a portion of its value as an insecticide, and emulsions containing less than 30 per cent. of the oil, although they do not at all, or only very slowly, rise to the surface when diluted with considerable quantities of water, are nevertheless too much weakened for effective use against Scale insects.

The killing power of a diluted emulsion depends less upon the amount of emulsion used in the solution than upon the percentage of oil contained in the emulsion. To increase the efficiency of an application we should rather add to the percentage of oil in the emulsion than increase the gross amount of emulsion used in a single application, the amount of the diluent remaining in each case the same. As the result of numerous experiments I would recommend an emulsion consisting of refined kerosene 2 parts; fresh, or preferably sour, cow's milk, 1 part (percentage of oil, 66⅔). Where cow's milk is not easily obtained, as in many parts of this State, it may be replaced by an equivalent of condensed milk (Eagle brand) diluted with water in the proportion 1 to 2. As the cans of condensed milk usually sold in the stores contain exactly 12 fluid ounces (three-quarters pint), the following receipt will be found a convenient one:

Kerosene	1 gallon	= 8 pints	= 64 per cent.
Condensed milk	2 cans	= 1½ "	= 36 per cent.
Water	4 cans	= 3 "	

Mix thoroughly the condensed milk and water before adding the oil; churn with the Aquapult pump until the whole solidifies and forms an ivory-white, glistening butter as thick as ordinary butter at a temperature of 75° F. If the temperature of the air falls below 70°, warm the diluted milk to blood heat before adding the oil.

In applications for Scale insects the kerosene butter should be diluted with water from 12 to 16 times, or 1 pint of butter to 1½ gallons (for Chaff Scale); 1 pint of butter to 2 gallons (for Long Scale). The diluted wash resembles fresh milk, and if allowed to stand, in two or three hours the emulsion rises, as a cream, to the surface. The butter should therefore be diluted only as needed for immediate use, and the mixture should be stirred from time to time.

A wash prepared in accordance with the above directions will kill with certainty all the coccids and their eggs under scales with which it can be brought into direct contact. No preparation known to me will, however, remove the scales themselves from the tree, or in any way reveal to the unassisted eye the condition of the insects within. This can be ascertained only by microscopic examination of detached scales. Time alone, and the condition of the tree itself, will indicate the result of an application. Kerosene, it is true, loosens the scales from the bark, so that for a time they are readily brushed off, but they afterwards become more firmly adherent, and are very gradually removed by the action of the weather.

Upon trees thickly infested a large proportion of the scales are so completely covered up by the overlapping of other scales, or the webbing together of leaves by spiders and other insects, that the wash cannot be brought into direct contact with them, and they are only reached, if at all, by the penetrating action of the oil. This takes place gradually, and the number of bark-lice killed increases for some time after an application, reaching the maximum in the case of kerosene about the fifth day. In Long Scale the oil penetrates the outer end, killing first the eggs at the broad and thin outer end, but its action is gradually exhausted and several pairs of eggs in the middle of the scale are often left alive. It is, therefore, impossible, in a single application, to destroy every scale upon an orange tree. This can, however, be accomplished by making two or three applications at intervals of four or five weeks. The mother insects being nearly or quite all killed by the first treatment, and the surviving eggs having in the interval all hatched, a second application, if thorough, will clear the tree.

The great difficulty experienced in reaching every part of the tree renders it absolutely necessary that any liquid used should be applied in fine spray and with considerable force. An ordinary garden syringe does not acomplish this and can never be used satisfactorily against Scale insects.

The most effective instrument known to me is the Aquapult force pump. This throws a constant stream of moderately fine spray with such force that the fluid is driven into close contact with the bark, and on striking the leaves and branches is dashed into fine mist which envelops the tree and wets every leaf. The tree should always be sprayed from each of four sides, and rather more liquid should be used than seems necessary to drench every portion.

Although I have thought it advisable to recommend several applications, a single very thorough spraying with a good force pump will, in most instances, prove entirely effectual in clearing the tree, since, if only an occasional egg or coccid escapes, the great army of parasites and enemies will be almost sure to complete the work.

As has been already said, diluted kerosene does no injury to young growth or to the bark of the orange trees. It however causes the older leaves to drop, and where the tree is badly infested with scale or otherwise out of condition the defoliation is sometimes complete, especially if the wash is applied in the sun. The death of moribund branches and twigs is also hastened. Beyond this the injury, if such it be considered, is imperceptible, and dormant trees are invariably stimulated to push out new growth in two or three weeks after treatment.

Even in midwinter, if the weather is mild, sprouts will show themselves, and this is perhaps the only objection to its use at this season, for it is clearly not desirable to start the buds at a time when there is danger of frost. During the past winter (1881-'82) I have experimented with many young trees, using emulsions containing from 40 to 80 per cent. of kerosene, and in no case has any real injury resulted, although some trees in very bad condition have lost a portion of their twigs and smaller branches that had been long infested with scale and were in a dying condition. In the spring, when the trees are in full growth and covered with tender sprouts, they may be sprayed with the diluted emulsion recommended above, without danger of checking their growth.

In Table 1 are given the results of seventeen experiments with kerosene in milk emulsions of varying strength. When the percentage of coccids killed is given this was obtained by cutting twigs, leaves, and portions of infested bark from all parts of the tree, and examining microscopically in the laboratory large numbers of the scales upon them. Under the head of young coccids are included all those which have well-formed scales but have not begun to lay eggs. The youngest bark-lice, or those which have not yet molted, were almost invariably killed and are not included in the enumeration.

The percentage of young coccids killed is given separately, including under this head all ages between the formation of the permanent scale and the appearance of eggs, but no larvæ before the first molt; the latter were in nearly every case all killed. Of scales which contained eggs three classes were examined, and the percentage of each obtained: (1) Scales in which a portion only of the eggs were destroyed; (2) Scales in which all the eggs were killed; (3) Scales in which no eggs were killed.

Purple Scales (*Mytilaspis citricola*) were not abundant but appear to be somewhat less readily destroyed than Long Scale. All the experiments were made upon young orange trees from three to six years old. An Aquapult pump of medium size was used, and in each case the trees were sprayed from the ground and on four sides. Where the trees were more than eight or ten feet in height, the upper branches did not receive the spray with sufficient force and show in some cases a smaller percentage of bark-lice destroyed than the lower portions of the same tree. For full-grown trees a larger pump is needed and the apparatus should be placed in a cart or otherwise raised above the ground when used.

The emulsions used were made as follows:

No. 2. Kerosene, 1 pint; sour cow's milk, 2 fluid ounces, dashed with a ladle; 2 drachms of powdered chalk was first added to the milk, and 2 ounces water during the stirring.

An imperfect emulsion not readily suspended in water.

No. 3. Kerosene, 1 quart; solution of condensed milk, 3 parts; water, 5 parts, 12 fluid ounces.

Emulsion made by spraying through the Aquapult pump and back into the pail. Stable, and readily suspended in water

No. 9. Kerosene, 1 quart; condensed milk, 12 fluid ounces, diluted with water, 36 ounces; emulsified with the Aquapult.

No. 10. Kerosene, 25.6 fluid ounces; condensed milk, 4.8 fluid ounces; water, 14.4 ounces; emulsified with pump.

No. 11. Kerosene, 2 quarts; condensed milk, 12 fluid ounces (1 can); water, 20 ounces; with pump.

No. 13. Kerosene, 2 quarts, 4 fluid ounces; condensed milk, 12 fluid ounces; water, 24 ounces; with pump.

WHALE-OIL SOAP.—This has long been considered one of the best insecticides known, and is extensively used as a remedy for bark-lice. Experiments show that very strong solutions kill the coccids but have little or no effect upon their eggs. Solutions of one pound of the soap to three gallons of water failed to kill the adult bark-lice or their eggs, and did not destroy all the young. The strongest solution used, one pound of the soap to one gallon of water, killed all the coccids and few or none of the eggs.

This solution solidifies on cooling, and must, therefore, be applied hot. The effect upon the trees is about equal to that of effective kerosene emulsions; badly infested trees are somewhat defoliated, but new growth and vigorous trees are not appreciably affected. As the eggs are not killed, several applications at intervals of four to six weeks will be required to clear a tree of scale.

Whale-oil soap is sold in Eastern Florida at 10 to 12 cents per pound. The cost of an effective wash is therefore much greater than emulsions of kerosene. For scrubbing and cleansing the trunks of orange trees this soap may be recommended. A solution of 1 pound to 4 gallons will probably be sufficiently strong for this purpose.

In Table 2 are given the results of experiments with solutions of whale-oil soap applied in fine spray to all parts of the trees by means of the Aquapult pump. The solutions were all applied hot, being either solid when cool or too thick for spraying through the pump.

OIL OF CREOSOTE.—The crude oil, dissolved in strong alkalies or solutions of soap, forms a very effective remedy for Scale insect. It may also be emulsified with milk in the same manner as kerosene. The undiluted oil is, however, exceedingly injurious to vegetation, and destroys the bark of orange and other trees. It is, in fact, a more dangerous substance than kerosene, and requires to be used with great caution. Solutions, emulsions, and soaps containing it should be very carefully mixed, in order that no globules of free oil may be allowed to come in contact with the bark of the tree.

Its action upon the Scale insect is even more powerful than kerosene, but it does not destroy as large a percentage of the eggs. The effect upon the coccids is not immediate, as in the case of other insecticides, and for three or four days after an application very few of the insects die. At the end of a week, however, the bark-lice are found to be affected and continue to perish in increasing numbers for a week longer. Even after the lapse of three weeks the destructive action of the oil is still appreciable. These facts lead me to suspect that the insects are killed, in part at least, by the poisoning of the sap upon which they feed.

The visible effect upon the plant appears to confirm this view. Leaves upon infested trees begin to drop after four or five days, and the defoliation reaches a maximum during the second week. As is the case with kerosene, the effect upon the tree depends upon its condition at the time of application; but creosote is more severe in its action, and there is greater loss of leaves and infested branches. With care, however, an application of creosote may be made sufficiently strong to exterminate the scale without serious injury to the plant, and, as new or vigorous growth is very slightly affected, recovery is rapid.

The following solution of crude oil of creosote will be found nearly if not quite as effective as a 64 per cent. kerosine emulsion, and may be applied without danger to orange trees. Dilute the creosote with twice its volume of soap solution (2 ounces common soap to 1 pint hot water). Mix thoroughly until all the oil is dissolved. Add, before using, to one part of the above solution nine parts water, and apply in as fine spray as possible.

The most effective method of using creosote is to saponify it with heavy oils and potash. In this way I have succeeded in obtaining a solid soap containing about 12 per cent., by volume, of the oil. The process of making the soap is, however, exceedingly tedious and difficult, and unless proper appliances be used the resulting product is imperfect and even dangerous to use, as it contains a large amount of free creosote. Manufacturers of carbolic soap could undoubtedly supply a better article and at a less cost than the consumer could make for himself.

In Table 3 are given results of experiments with oil of creosote in solution and combined with other substances.

In experiment No. 27, 9 fluid ounces of creosote was applied to a single tree about five years old. The tree, which was badly infested with Long Scale, and had many branches dead or dying, was severely defoliated, and lost some moribund branches, but recovered in six weeks and pushed out new growth in midwinter.

In experiment No. 30 a pint measure of crumbled creosote soap was applied. The actual amount of creosote contained in this soap did not exceed 2 fluid ounces. The extermination of Long Scale was complete. The tree, which was very badly infested and in poor condition, was almost completely defoliated and lost half its branches, but recovered very rapidly and pushed out new leaves within thirty days. (January 25.)

In experiment No. 21 the other substances added to the creosote solution increased the injury to the foliage of the tree and it was very severely checked, but entirely recovered and was stimulated to vigorous growth at a time when all surrounding trees were dormant.

In the remaining experiments, 13, 14, 15, and 12, the quantity of creosote used was not sufficient to kill the Scale insects. The effect upon the trees was also very slight.

Although from the greater danger which attends its use and its less effective action upon the eggs, creosote cannot be preferred to kerosene as a remedy for scale, orange growers will be glad to find in it a specific against certain destructive bark fungi which are often mistaken for scale and are very frequently associated with it. One of these fungi is very widely distributed in Eastern Florida, and in some groves affects the health and endangers the life of every tree. It appears upon the trunk and branches as little, hard excrescences, of gray color, sometimes bursting at the end and disclosing a white, cottony interior, from which they are often confounded with a coccid, and are called the "mealy bug." A single application of cresote solution will usually entirely destroy the mycelium of this fungus within the bark and cause its disappearance from the tree.

BISULPHIDE OF CARBON.—In Table 4 are given the results of several experiments with this insecticide. The emulsion, of which the ingredients are given in the table, was formed by beating together with a spatula the carbon and lard oil and then adding the milk and water, and emulsifying in the same manner.

The trees in experiments 40 and 41 were very severely checked, although not seriously injured, and all subsequently recovered.. In experiment 39 the mixture was applied during a rain, and was entirely without effect upon the tree or scale.

Further experiment is needed to determine whether this substance can be safely and economically used as a remedy for scale. Although a powerful insecticide, the danger to the trees and the cost of the materials detract greatly from its value. It is also exceedingly volatile and explosive, and is to some extent poisonous to man.

NEAL'S EXTERMINATOR.—This preparation has been used to a limited extent in Putnam County, Florida, and is superior to most of the proprietary washes in the market. It is a liquid, soluble in water, and is applied with a brush or in spray. It soon dries when exposed to the air, and forms a gum, which coats the tree and in part peels off, carrying with it many of the old dead scales and some living ones. When applied in sufficient strength it kills most of the coccids but does not destroy the eggs. It checks the tree rather more than kerosene, with which it cannot be compared in efficiency or cheapness. The preparation is inert and harmless to man and acts mechanically by covering and stifling the bark-lice or by removing them bodily from the tree.

Table 5 gives the result of a single experiment in which the "exterminator" was diluted in the proportions recommended by the proprietor. In other trials, with stronger solutions, the best result obtained was 80 per cent. of the young coccids killed, and trees were cleared of scale by repeated applications at intervals of several weeks; but in these cases the bark was hardened and the growth of the trees somewhat checked.

LYE.—Four experiments with concentrated potash lye, given in Table 6, sufficiently illustrate the worthlessness of this substance as a remedy. In the strongest solution one pound of solid lye to a gallon and a half of water, all applied upon a single, very small tree, only a small percentage of young Long Scales were killed; Chaff Scales did not appear to be affected, and eggs or adult coccids entirely escaped. The tree was, however, seriously injured, and lost nearly all its leaves, with many of the smaller branches.

Solutions of one pound to two, two and a half, and three gallons had no appreciable effect upon the insects, but all seriously affected the foliage and even the bark of the trees.

SULPHURIC ACID.—A single experiment with sulphuric acid, 4 fluid ounces in 6 quarts of water, applied with a brush as far as possible to all parts of a young tree, killed nearly all the Scale insects, and very nearly killed the tree. The bark was blackened but not destroyed, and nearly all the leaves dropped. The tree, however, slowly recovered.

SULPHATE OF IRON.—This substance is exceedingly injurious to vegetation, but is, nevertheless, a very common ingredient of patent and proprietary remedies. Its presence can be detected by the inky-black or brown stains which it forms in the substance of the leaves and the rind of the fruit.

It does not affect the Scale insect except by destroying the vegetable tissues from which it gets its subsistence.

AMMONIA.—With this in a pure state no experiments have been made, but to its presence in fermenting urine is probably due the insecticide properties of the latter. Applications of urine have often been recommended as a remedy for scale, and are certainly not without value, but if allowed to stand and ferment, and especially if soot or other absorbents of the ammonia are mixed with it, it becomes highly injurious to vegetation, and if applied at all should be greatly diluted. A mixture of soot and fermented urine applied undiluted to a small orange tree effectually cleared it of scales but very nearly killed the tree.

Very many substances used separately, or in various combinations, are recommended as remedies for Scale insect. Among the number I have examined with more or less care the following, and find them to be of doubtful or of no value: sal-soda, muriate of potash, salt, lime, sulphur, soot, and ashes.

Many otherwise valueless washes and applications have been rendered partially effective by the addition of a small quantity of free kerosene. The result in all such cases has been a very unequal distribution of the oil, some portions of the tree receiving a dangerous dose and other portions none at all. It seems hardly necessary to point out the uselessness of such half-way measures in combatting a pest which the most perfect remedy is powerless to eradicate unless applied with thoroughness and care.

TABLE 1.—KEROSENE EMULSIONS.

No. of experiment.	No. of emulsion.	Kerosene in the emulsion.	Emulsion diluted with water.	Amount of dilute wash applied.	Date of application.	Date of examination.	Long Scale (*M. Gloverii*). Young coccids killed.	Long Scale: Scales containing eggs. Eggs, in part killed.	Long Scale: Scales containing eggs. Eggs, all killed.	Long Scale: Scales containing eggs. Eggs, none killed.	Chaff Scale (*P. Pergandii*). Young coccids killed.	Chaff Scale: Scales containing eggs. Eggs, in part killed.	Chaff Scale: Scales containing eggs. Eggs, all killed.	Chaff Scale: Scales containing eggs. Eggs, none killed.	Remarks.
		pr. ct.	*Parts.*	*Qts.*			*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	
10	2	80	1 to 16	10	Oct.	Oct. 22	99	39	61	0	......	......	......	......	Bark, leaves and twigs of lower branches.
						Oct. 25	93	58	29	13	......	......	......	......	Thorns from upper branches. November 10, a few gravid females still living, also a few young scales forming from eggs recently hatched.
10	11	67	1 to 16	6	Nov. 14	Nov. 17	......	......	......	......	......	......	......	......	Second application effectively cleared the tree of scales; only an occasional gravid scale found alive on upper branches.
11	3	73	1 to 64	6	Oct. 22	Oct. 25	25–30	......	0	99+	......	......	......	......	No appreciable effect upon eggs or mature coccids.
29	11	67	1 to 9½	6	Nov. 14	Nov. 19	71	43	18	39	......	......	......	......	Thickly infested bark of lower limbs. Upper branches give variable results.
						Dec. 26	100	......	100	......	......	......	......	......	Bark, twigs, and leaves from all parts. Prolonged examination; not a living coccid or egg can be found. Mites swarm under the dead scales and have probably completed the work of the wash.
24	11	67	1 to 16	6	Nov. 11	Nov. 18	91	87	19	44	63	65	0	35	
28	11	67	1 to 16	6	Nov. 14	Nov. 19	......	......	......	......	......	......	......	......	Result about the same as in No. 24, or slightly less effective and variable.
25	11	67	1 to 16	4	Nov. 11	Nov. 19	78	29	8	63	......	......	......	......	Variable; some branches give poor results. Evidently not enough liquid used for thorough application.
31	11	67	1 to 16	3	Nov. 14	Nov. 18	......	......	......	......	22	......	5	95	Small tree, but not sufficient wash used. Effect on Long Scale about equal to No. 25. Lecanium Scales killed only where the spray struck with force.
26	11	67	1 to 16	2	Nov. 11	Nov. 19	......	......	......	......	......	......	......	......	Small tree, but amount of wash applied entirely insufficient. Many branches show no effect. Very few Long Scale killed.
33	13	65	1 to 16	6	Dec. 8	Dec. 12	......	......	......	......	......	......	......	......	Result about the same as in No. 24. Second application four days later.
33	13	65	1 to 16	9	Dec. 12	Feb. 4	......	......	......	......	......	......	......	......	Almost complete extermination of Long Scale. A few living coccids found upon a twig from upper branches. On the same twig a few living Chaff Scale were also found.

17	10	57	1 to 16	6	Nov. 4	Nov. 9	25 to 50	......	......	......	......	......	......	......	Action very unequal upon different parts of the tree. Examination made too soon after application to show full effect of the wash.
18	10	57	1 to 16	6	Nov. 4	Nov. 10	......	......	......	......	Few	......	......	......	Effect upon Chaff Scale very slight. On some leaves nearly all killed.
						Jan. 30	......	......	......	......	......	......	......	......	Tree less infested than formerly and condition much improved, but not cleared of scales. Chaff Scale beginning to increase again. Some Long Scale still living.
20	9	40	1 to 8	6	Nov. 4	Nov. 10	......	......	......	......	......	......	......	......	Chaff Scale not appreciably affected. Long Scale killed to some extent. *Lecanium hesperidum* not killed.
						Jan. 30	......	......	......	......	......	......	......	......	Application not effective in clearing the tree. Chaff Scale will soon begin to increase.
16	9	40	1 to 11	6	Nov. 3	Nov. 9	45	87	14	49	......	......	......	......	Leaves and twigs .... } Chaff Scale much less affected.
						Nov. 9	86	......	......	......	......	......	......	......	Exposed bark of upper branches. } Chaff Scale much less affected.
						Nov. 10	72	20	19	61	......	......	......	......	Leaves, twigs, and bark of main branches. Chaff Scale less affected; not counted.
						Nov. 11	100	40	0	60	......	......	......	......	A single large leaf.
						Jan. 25	......	......	......	......	......	......	......	......	Long Scale and Chaff Scale beginning to increase and entering upon a new brood.
19	9	40	1 to 24	6	Nov. 4	Nov. 10	......	......	......	......	......	......	......	......	Tree infested with Chaff Scale only. Effect on scales scarcely appreciable.
						Jan. 30	......	......	......	......	......	......	......	......	Application has had little or no effect. Number of living scales has neither increased nor diminished. New brood beginning to hatch.
23	......	......	......	6	Nov. 4	Nov. 11	......	......	......	......	......	......	......	......	Imperfect emulsion made by churning together one-half pint of kerosene, 12 fluid oz. (?) condensed milk, and 6 quarts water. Application very unequal owing to imperfect mingling of the oil and water. Young of Long Scale killed on some branches and not killed on others. Eggs for the most part uninjured. Some infested leaves show all coccids killed on one side; all living on the other side.

TABLE 2—WHALE-OIL SOAP.

No. of experiment.	Whale-oil soap solutions.					Long Scale (*M. Gloverii*).				Chaff Scale (*P. Pergandii*).				Remarks.
							Scales containing eggs.				Scales containing eggs.			
	Soap.	Water.		Date of application.	Date of observation.	Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	
	Lbs.	*Qts.*				*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	
34	1	4	4½ quarts applied hot.	Dec. 6	Dec. 17	100	0	0	100	95 (?)	0	0	100	Tree infested with Long Scale, and a few scattered Chaff Scale; nearly every coccid, old and young, killed; a very few Chaff Scale still alive; eggs of both scales absolutely uninjured; tree rather large; not enough liquid used.
					Jan. 28	......	......	......	......	......	......	......	......	Long Scale completely exterminated; eggs and young probably destroyed by mites; living Chaff Scale, nearly all young or nearly adult, numerous on some parts.
33	1	6	6 quarts applied hot.	Dec. 6	Dec. 16	100	24	15	61	......	......	......	......	Small tree; very thorough application; at noon in the sun.
					Jan. 28	......	......	......	......	......	......	......	......	Both Long and Chaff Scale completely exterminated upon nearly all parts of the tree; several twigs, however, have escaped thorough wetting, and are still moderately infested with one or both kinds of scale.
35	1	8	8 quarts applied hot.	Dec. 8	Dec. 17	95	0	0	100	......	......	......	......	Tall tree; difficult to cover with liquid; adult female coccids not all killed.
					Jan. 28	......	......	......	......	......	......	......	......	A few individual Long Scale found alive on some branches; 1 or 2 per cent. living.
36	1	10	5 quarts applied hot.	Dec. 8	Dec. 26	90	0	0	100	......	......	......	......	Small tree; Long Scale which have not completed the first molt are all killed; the proportions given include coccids from passed first molt to adult; a few Chaff Scale seen, all living; no gravid ♀ coccids killed.
37	1	12	6 quarts applied hot.	Dec. 8	Dec. 26	70	0	0	100	0 (?)	0	0	100	Small tree; thorough application; a few Chaff Scale intermingled seem not to have been affected.

TABLE 3—CREOSOTE.

Number.	Oil of Creosote; amount used in single application.		Diluted with water.	Amount of diluted wash applied.	Date of application.	Date of examination.	Long Scale (M. Gloverii).				Chaff Scale (P. Pergandii.)				Remarks.
								Scales containing eggs.				Scales containing eggs.			
							Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	
			Qts.	Qts.			pr. ct.	pr. ct.	pr. ct.	pr. ct.	pr. ct.	pr. ct.	pr. ct.	pr. ct.	
27	9 fluid oz...	Dissolved in soap, 2 ounces; hot water, 1 pint.	4½	6	Nov.12	Nov. 14	......	......	......	......	......	......	......	......	Long Scale only. Very few young and no eggs killed.
						Nov.21	94	41	17	42	......	......	......	......	Bark of vigorous shoot infested with scales of last brood, and nearly all young. All scales before first moult are killed and not enumerated. Older scales still dying.
						Nov.21	77	21	12	67	......	......	......	......	Leaves from less infested portions of the tree.
						Jan. 25	......	......	......	......	......	......	......	......	Scales completely exterminated upon most parts. In a few places young are forming. On exposed branches very few or no scales alive. Other portions give 3 per cent. living.
30	2 fluid oz...	Creosote soap*—16.8 fluid oz.	6	6	Dec. 5	Dec. 16	100	26	29	45	......	......	......	......	Gravid females all killed. Long Scale only.
						Jan. 25	......	......	......	......	......	......	......	......	On minute and careful examination, not a single living coccid or egg can be found.
47	1 1/10 fluid oz.	Id. .... 9 fluid oz.	6	6	Jan. 10	Jan. 21	100	43	48	9	60	11	4	85	Chaff scales on outside have been killed; scales protected by others overlapping them are alive. Eggs but little affected.
						Feb. 2	......	......	......	......	......	......	......	......	Long Scale nearly exterminated. Chaff Scale but slightly checked, and now increasing.
32	1 fluid oz..	Id. .... 8.4 fluid oz.	6	6	Dec. 5	Dec. 16	99+	20	0	80	......	......	......	......	A single living coccid seen. Eggs slightly affected.
46	¾+ fluid oz.	Id. .... 4.5 fluid oz.	6	6	Jan. 10	Jan. 21	96	13	2	85	42	0	0	100	Two small trees washed; (1) infested with Long Scale; (2) infested with Chaff Scale. On some twigs of the latter, only ♂ pupæ appear to be killed. Lecanium Scales nearly all killed.

*Creosote, 12 % by volume; lard oil, 60 % by volume; concentrated lye, 20 % by volume; water, 8 % by volume. (Solidified by long continued boiling. Loss by evaporation estimated, and above proportions given as approximate only.)

TABLE —CREOSOTE—*Continued.*

Number.	Oil of Creosote; amount used in single application.		Diluted with water.	Amount of diluted wash applied.	Date of application.	Date of examination.	Long Scale (*M. Gloverii*). Young coccids killed.	Long Scale: Scales containing eggs. Eggs, in part killed.	Long Scale: Scales containing eggs. Eggs, all killed.	Long Scale: Scales containing eggs. Eggs, none killed.	Chaff Scale (*P. Pergandii*). Young coccids killed.	Chaff Scale: Scales containing eggs. Eggs, in part killed.	Chaff Scale: Scales containing eggs. Eggs, all killed.	Chaff Scale: Scales containing eggs. Eggs, none killed.	Remarks.
			Qts.	*Qts.*			*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	
46	....	[Continued]	......	......	....	Feb. 2	......	......	......	......	......	......	......	......	Living eggs and young scales found on both trees. Long Scale slightly checked; Chaff Scale not at all.
21	4⅛ fl. oz..	Dissolved in soap, 2 ounces; hot water, 12 ounces; together with silicate of soda, 13 fl. ounces; water, 12 ounces; urine, 7 fl. oz.	4	5+	Nov. 7	Nov. 10 Nov. 19	91 90	56	0	44					Many scales full of dead larvæ which have hatched since application, but unable to issue. In many scales the eggs are partly or all killed; mother coccids in many cases still alive. Scales severely checked; no new scales forming.
13	2 fluid oz..	Emulsified with condensed milk, 4 fl. oz.; water, 1 oz.	5	5+	Oct. 26	Oct. 31	......	......	......	......	......	......	......	......	Tree infested with Long Scale. No appreciable effect upon the scales.
14	1.13 fl. oz..	Emulsified with sour condensed milk, 78 pr. ct.; to creosote, 22 pr. ct.	6	6	Oct. 31	Nov. 5	......	......	......	......	......	......	......	......	Long Scale. No appreciable effect.
15	3/16 fl. oz..	Emulsified together with 2.7 fluid oz. of kerosene and 2.64 fluid oz. of sour milk curds. Oil creosote ....14 pr. ct. Oil kerosene........42 pr. ct. Curds of milk ......44 pr. ct.	6	6	Oct. 31	Nov. 5	......	......	......	......	......	......	......	......	Long Scale very slightly affected. Not over 20 per cent. of the young scales killed. No mature females and no eggs killed.
12	⅛ fluid oz.	Solution in water, made by triturating 1 fl. oz. creosote with 2 oz. carb. magnesia and filtering in 1 quart water.	2	2	Oct. 25	Nov. 2	......	......	......	......	......	......	......	......	Long and Chaff Scale. No effect whatever.

TABLE 4.—BISULPHIDE OF CARBON EMULSION.

[Bisulph. carb., 56 per cent.; lard oil, 19 per cent.; condensed milk, 6 per cent.; water, 19 per cent.]

Number of experiment.	Amount of bisulphide used in single application.		Diluted with water.	Amount of diluted wash applied.	Date of application.	Date of examination.	Long Scale (*M. Gloverii*).				Chaff Scale (*P. Pergandii*).				Remarks.
								Scales containing eggs.				Scales containing eggs.			
							Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	
			Qts.	*Qts.*			*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	
41	9 fluid oz. .	In emulsion, 16 fluid oz	5½	6	Dec. 31	Jan. 20	52	0	0	100	......	......	......	......	Very tall tree. Application made on a windy day and upper branches not thoroughly sprayed; gives varying results, some young and nearly all eggs alive. Other parts of tree have been entirely cleared of living young, but a large proportion of eggs escape. (a) Thorn from upper branches. Long Scale.
							100	35	43	22	......	......	......	......	Leaves, thorns, and twigs from lower branches. Gravid females of Long Scale all killed. A few Chaff Scale examined; coccids killed but eggs alive.
40	5.6 fluid oz.	In emulsion, 10 fluid oz	6	{ 4 { 2	Dec. 31 Dec. 31	Jan. 21 Jan. 21	} 100	3	96	1	97	0	98	2	Two trees sprayed, one very small; both infested with Long Scale and Chaff Scale together. Trees nearly cleared of scale, in part by the aid of parasites. Application more thorough than No. 41.
39	3 + fluid oz.	In emulsion, 6 fluid oz	6	6	Dec. 15	Dec. 26	......	......	......	......	......	......	......	......	Applied in rain on windy day; not a satisfactory application. No eggs, and apparently no young coccids killed. Examination January 25 gave same result; scales increasing.

TABLE 5.—NEAL'S EXTERMINATOR.

Number of experiment.	Amount of exterminator or potash used in single application.		Diluted with water.	Amount of diluted wash applied.	Date of application.	Date of examination.	Long Scale (*M. Gloverii*).				Chaff Scale (*P. Pergandii*).				Remarks.
								Scales containing eggs.				Scales containing eggs.			
							Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	Young coccids killed.	Eggs, in part killed.	Eggs, all killed.	Eggs, none killed.	
			Qts.	*Qts.*			*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	*pr. ct.*	
22	16 fluid oz.	Neal's exterminator, diluted 1 to 9.	4½	5	Nov. 7	Nov. 10	43	0	0	100	......	......	......	......	Gravid females and eggs not injured. Chaff Scale; young slightly affected, eggs not at all.

TABLE 6.—POTASH SOLUTIONS.

Number of experiment.	Amount of exterminator or potash used in single application.		Diluted with water.	Amount of diluted wash applied.	Date of application.	Date of examination.	Long Scale: Young coccids killed.	Long Scale: Eggs, in part killed.	Long Scale: Eggs, all killed.	Long Scale: Eggs, none killed.	Chaff Scale: Young coccids killed.	Chaff Scale: Eggs, in part killed.	Chaff Scale: Eggs, all killed.	Chaff Scale: Eggs, none killed.	Remarks.
42	1 pound...	Concentrated potash lye, 1 lb.	6	6	Dec. 31	Jan. 20	87	0	0	100	......	......	......	......	Only a few Chaff Scales examined; all of them alive.
43	1 pound...	......do ....1 lb.	8	8	Jan. 2	Jan. 9	......	......	......	......	......	......	......	......	Long Scale only. No appreciable result.
44	½ pound...	......do ....1 lb.	10	5	Jan. 2	Jan. 9	0	0	0	100	0	0	0	100	Long and Chaff Scale together. No result whatever.
45	½ pound...	......do ....1 lb.	12	6	Jan. 2	Jan. 9	0	0	0	100	0	0	0	100	Do.

NOTE.—The above report by Mr. Hubbard is a summary of practical work done in the orange insect investigation at Crescent City, Florida, and is prepared at our request in advance of the special report on the subject. It is especially valuable because of the thorough experiments with kerosene which it embodies. Not that they are final, for other satisfactory methods of emulsifying petroleum have been obtained by other experimenters and give promise of usefulness. We have for years been endeavoring to solve the question of the safe and effective use of petroleum on plants because of its well-known value and wide application as an insecticide. Emulsions with soapsuds and lye had been worked at some years ago by Professor Taylor, the microscopist of the Department, and more recently they have been made by several independent experimenters in Florida, but particularly by Mr. Joseph Voyle, an intelligent correspondent at Gainesville, who uses kerosene, soap, and fir-balsam combined at a high temperature, and produces a permanent paste which he calls "murvite," readily soluble in water. Recent experiments made at our request by Mr. Clifford Richardson, assistant chemist of the Department, with ordinary soap, whale-oil soap, and both light and heavy oils, also show that 20 parts hard soap, 10 parts water, 40 parts kerosene, and one part balsam, produce the most satisfactory results. The substances may be readily mixed into a permanent paste which dilutes *ad libitum* with water, forming a milk-like fluid upon which a slight cream in time rises, but which is always easily rendered homogeneous upon slight shaking. Mr. Hubbard's experiments would indicate, however, that for insecticide purposes, nothing equals the milk emulsions which were first suggested by Professor Barnard, during our work on the Cotton Worm at Selma, Ala., in 1880, and though the use of ordinary emulsifying agents, as various mucilaginous substances and the phosphates, lactophosphates and hypophosphites of lime may facilitate the making of kerosene emulsions, we have not yet had them sufficiently tested as insecticides, and for the present can recommend nothing more simple and at the same time more available to the average farmer than the permanent milk emulsion as produced by Mr. Hubbard.—C. V. R.

INSECTS AFFECTING THE RICE PLANT.

During the past two years a correspondence with Colonel Screven, Mr. Thomas Barnwell, and other prominent rice planters on the Savannah River has shown that the rice crop, although the conditions of its cultivation would seem to prevent insect multiplication, is nevertheless affected to a considerable degree by injurious species.

The importance of the crop thus affected is shown by the following table of the rice production of the United States in 1879, taken from an extra bulletin of the Census Office:

States.	Acres.	Pounds.	Average yield per acre (pounds).
Alabama	1, 579	810, 889	514
Florida	2, 551	1, 294, 677	508
Georgia	34, 973	25, 369, 687	725
Louisiana	42, 000	23, 188, 311	552
Mississippi	3, 501	1, 718, 951	491
North Carolina	10, 846	5, 609, 191	517
South Carolina	78, 388	52, 077, 515	664
Texas	335	62, 152	186
Total	174, 173	110, 131, 373	632

In August, 1881, we sent one of our assistants, Mr. L. O. Howard, to Savannah to collect and study such insects as prove injurious to rice, and we here introduce short accounts of the principal species observed. The observations were mostly made at "Proctor's," a large plantation five miles below Savannah on the South Carolina side, owned by Colonel Screven, and, together with the facts elicited by correspondence, cover about all that is known respecting the insects affecting this crop in the field; for, although something is known of the insects affecting the plant in the East Indies, and quite recently accounts have been published abroad of the great injury by a new enemy (*Cecidomyia oryzæ;* Wood-Mason) there, yet little has, until quite recently, been known of those affecting the crop in this country.

THE RICE GRUB.

(*Chalepus trachypygus* Burm.)

Order COLEOPTERA; family SCARABÆIDÆ.

[Plate VI, Fig. 5.]

HABITS AND NATURAL HISTORY.

The larvæ of this large beetle, quite closely related to the Sugar-cane beetle (*Ligyrus rugiceps*, Lec.) and the Sunflower beetle (*L. gibbosus*, De Geer), and working in much the same manner, have done considerable damage in certain portions of the rice plantations. Our attention was originally called to this insect by a letter from Colonel Screven, which was published with the identification in the *American Entomologist* (III, p. 253, 1880). Further notes were published in the *American Naturalist*, 1881, p. 148. Mr. Howard's observations, as taken from his report, are as follows:

At the back of Proctor's, a mile or more from the river, and bordering upon the forest, is a tract of land which, from its elevation, it is impossible to overflow properly and sufficiently to make a good crop of rice, yet it is planted and a small crop raised from it. On walking through this field I observed that in patches the growth was very slight and the clusters were dwarfed and yellow. Pulling up a clump by the roots two or three large white grubs were exposed which I surmised must be the larvæ of the *Chalepus* spoken of in the *American Entomologist*. A search of an hour or so turned up hundreds of the grubs and a single specimen of the adult beetle, but no pupæ.

This field, then, was evidently the breeding-place from whence came the beetles which injured the young rice in May and June. The fields are drained for planting in March, the young rice grows fast, and in May the beetles appear, and, working into the ground, feed upon the roots of the plants. When, however, in June, the fields are flooded with the harvest-water the beetle and the grub (which will have hatched before that time) are drowned out and do no more harm except in such spots as are not reached by the water. During all the rest of the year the insect will be found in all probability in such fields as the one mentioned.

But not alone from such chance fields as this are the plantations supplied in early summer with the beetles, for along the backs of the plantations and along the banks between fields above the water-mark grows a certain quantity of volunteer rice, and upon its roots the beetles and their larvæ feed unmolested and fly out in spring to stock the drained fields.

The remedy will be found in planting such fields as cannot be thoroughly overflowed at will for a year or so in some other crop than rice, and in cleaning out as thoroughly as possible such volunteer rice as grows above the water-mark. The Chalepus is an insect which a little care will render innoxious. I was unable to learn that it had injured upland rice in the back country, but as that crop increases in importance it is highly probable that it will be heard from, and there it will be almost impossible to fight it successfully. There seems to be but one brood a year.

The beetles from the larvæ sent by Mr. Howard issued in the latter part of September and in early October.

STRUCTURAL AND DESCRIPTIVE.

The genus Chalepus belongs to the tribe Dynastini of the Scarabæidæ Pleurosticti, in which subfamily the posterior abdominal spiracles are placed in the ventral portion of the abdomen. Omitting here the genus Phileurus, the North American genera of this tribe form two divisions, the first containing those forms in which the head or thorax are armed in both sexes, the best-known illustration being *Dynastes tityus.* The second division includes the genera with unarmed head and prothorax. There are only two of these genera existing in our fauna, Cyclocephala and Chalepus, distinguished from each other by the form of the mandibles, which in the former genus are narrow and scarcely curved, while in Chalepus they are broad, rounded externally, and curved. There are no stridulating organs in either genus, and the males have the terminal joint of anterior tarsi much enlarged. Both genera are peculiar to the New World, being, however, best represented in South America. Of Cyclocephala quite a number of species occur in the more southern portions of the United States, but only two species of Chalepus are known from North America, *C. obsoletus,** from Southern California, and the species under consideration, which occurs from New York southward and westward extending to Texas and Mexico. It appears to be most frequent in Georgia, Alabama, and Florida. It may be recognized by the following characters:

Average length, 16^{mm}. Black, shining; antennæ, mouth parts and tarsi piceous-red. Clypeus, *flat*, truncate in front, finely margined, anteriorly almost smooth, posteriorly finely and sparsely punctulate; head *entirely unarmed*, sparsely punctulate. Thorax bisinuate in front, truncate at base, *unarmed*, sparsely and irregularly punctate, base margined only near the angles. Elytra, oblong-oval, a little shorter in the female; a single sutural and four pairs of dorsal striæ composed of shallow approximate punctures, the striæ themselves hardly impressed; outer pair of striæ less regular and connected with the third pair at the humeri; interstices between each pair of striæ wide, irregularly, not densely punctulate, interstices between the individual striæ of each pair narrow and smooth; apex of elytra irregularly, coarsely and rugosely punctate. Beneath, very shining, smooth; sides of mesosternum and of abdomen punctate. Anterior tibiæ tridentate.

The larva has the general aspect of the ordinary White Grub, and may be recognized with the assistance of our figure. We append a description for the benefit of Coleopterists:

Full-grown larva.—Length when crawling about 31^{mm} (about an inch and a quarter). The curve of the body is not very pronounced. Color white, although most specimens have a bluish tinge on account of the black earth with which they are filled, the last two joints appearing almost black; labrum and basal two-thirds of mandibles reddish brown; a spot at the inner base of mandibles, and the apical third of mandibles, black; antennæ and the other mouth parts and legs pale-brownish-yellow; stigmata orange; a poorly-defined yellowish spot above the first abdominal stigmata; a corneous yellowish ridge from the first pair of legs to the base of the head, brown at edge. Body sparsely clothed with hairs and with a transverse row of bristles on each dorsal ridge, most marked on joints 2 to 6; a number of stiff hairs around dorsal margin of anal joint. Ventral surface of abdomen beset with brown bristles. Antennæ 4-jointed, with a pronounced bulbus; joints 1 and 2 long, subequal in length; joints 3 and 4 subequal in length and each somewhat more than half as long as 1; joint 3 with a slight prolongation on its inner side at tip; maxillary palpi 3-jointed, joints subequal in length; labial palpi small, 2-jointed; mandibles large with four pronounced teeth, of which the second and third are smallest and are closely united; maxillæ 4-dentate. Whole surface of head and base of labrum quite closely punctate and furnished with sparse yellowish bristles; terminal portion of labrum and the mandibles not punctate, but with delicate, sparse, impressed lines.

*We have had no opportunity to examine this species, which was described by Dr. Le Conte in the Proceedings Ac. Sc., Philad., 1854, p. 222.

THE WATER WEEVIL.

(*Lissorhoptrus simplex* Say.)

Order COLEOPTERA; family CURCULIONIDÆ.

[Plate VI, Fig. 4.]

HABITS AND NATURAL HISTORY.

For many years the rice planters of the Savannah have been familiar with two insects which they have called "the maggot" and the "Water Weevil," the former a minute, white, rather slender, legless grub, living at the roots of the plant, and the latter a small, gray weevil feeding upon the leaves. To Col. John Screven is due the credit for the first suggestion of the identity of these two insects—that the maggot is the larva form of the weevil,—and we quote from his letter which we published in the *American Naturalist* (1881, p. 483), in connection with some remarks of our own on the scientific position of the species:

I send you by express a number of "Water Weevils" preserved in alcohol, together with some specimens of the young rice leaves on which they were found feeding. You will observe on the latter the method of the insect in feeding, and will find no difficulty in concluding that when in sufficient numbers, as is sometimes the fact, they may do much damage in the rice-fields.

I have observed with great interest and attention your allusion to this insect in the general notes from the *American Naturalist*, February, 1881. But it has suddenly occurred to me as possible that these "Water Weevils" are the perfect insect of the "maggot" larva which I sent you last summer. Allow me to suggest some reasons for this opinion.

1. Both the weevil and the maggot are water insects; both seek the same food, namely, the rice plant, differing, however, in this, that the one feeds on the leaf and the other on the root of the plant.

2. They differ in the periods of existence, the weevil appearing in April and May, the maggot in the summer months; but this may account merely for the time and circumstances necessary to incubation. Among the specimens sent you, I found several pairs in what appeared to be the act of copulation. These specimens were taken yesterday, April 29, many of them *in the very spot where were found the maggots which I sent you last summer*. My first note of the latter was July 13, and allowing one week for the appearance of the weevil after the fields are inundated for the stretch flow, the latter would be found, say, April 17, making an interval of, say, ninety days between weevil and maggot, or between the beetle and the larva. This may appear an over-long period, but I assume that water is necessary to the generation and existence of this insect. Now, the "stretch water" does not last more than thirty days. At the expiration of this time the fields are drained and kept dry for at least thirty, very often forty, days, and I presume that from this fact, forbidding incubating during this period, it would not commence until the harvest-flow is put on the fields. In 1880 this flow was applied, say, June 18. The maggot was found July 13, say, thirty days after. I am quite ignorant of the periods of insect incubation, but it appears that if water is necessary to the generation and existence of this insect, the "maggot" larva, if from the Water Weevil, will hatch within thirty days after the harvest water is applied to the field.

3. The Water Weevil and the maggot are found in the same habitat, and both disappear on the removal of the water in which they live. I may note here that the weevil is sluggish in its habits, is easily caught, and never "plays 'possum." It is seen in the greatest numbers in the early morning, feeding on the delicate leaves of the plant, and seeks, crawling down the stem, the cooler recesses under water as the sun grows warmer. Many, however, feed all day.

The following is quoted from Mr. Howard's report:

The Water Weevil is a very common insect in the rice-fields, and I judge from my observations that only when it exists in enormous numbers is the damage appreciable. At the time of my visit the larvæ in all stages of growth were very abundant at the roots of the rice, while the adults were comparatively rare. Almost any healthy-looking clump of rice when pulled up showed, upon careful examination, the white grubs at the roots. They are rather difficult to find on account of their small size, and the best way to obtain them is to carefully wash away the dirt from the roots in a basin of water. Upon finding the first larva I carefully examined the nearest rootlets, but could find no marks of injury, yet the grubs undoubtedly feed upon them. Occasionally in a field would be seen a clump or so, or even a patch, which had a yellow, sickly appearance, quite characteristic, and differing from the "blast" spoken of later. Upon the roots of such clumps the larvæ were always more abundant. I have counted twenty-three upon the roots of a single seed clump, and there were undoubtedly some which escaped my attention.

This larva does not make its appearance on the roots until the harvest water is put on. I saw no specimens on the roots of rice in the *dry* field, which was infested by Chalepus. Colonel Screven, who has studied the point very carefully, is of the opinion that the larva is dependent for its existence upon the water. The beetle has gotten its common name of "Water Weevil" from the fact that it is found only when the fields are overflowed.

Hence, Colonel Screven proposes, in case of extensive damage by these larvæ, to drain the fields as a remedy. That this would prove quite satisfactory, if persisted in sufficiently, I feel satisfied, both from a comparison of the overflowed and dry fields, and from the fact that the spiracles of the larvæ while present are few and rudimentary; but it would take so long for the fields to dry out sufficiently that meantime the crops would suffer even more, perhaps, than by the attacks of the weevils. It may also be urged against this proposed remedy that this insect undoubtedly breeds upon other water plants and is far from being confined to rice; hence, even if the larvæ were effectually "driven out," the fields would soon again become populated from other sources.

No pupæ were found by Mr. Howard, and the beetles were quite rare in the fields at the time of his visit (August 20), and were difficult to capture when found. Their favorite station, in midday at least, is down in the sheath of the leaves, out of sight, or nearly so. Although sluggish they drop into the water when disturbed. In the adult state they do but little damage unless very numerous. Their work on the leaves is usually perceptible as a brownish patch near the mid rib. The leaf is not cut entirely through by them.

From the information at hand it is impossible to state the number of broods. According to Colonel Screven's letter, the beetles were very abundant in late April and May, and presumably disappear later. Mr. Howard, the third week in August, found full-grown larvæ and a few beetles, so that there was abundant time for the production of another generation.

The species is extremely common in all parts of the United States (east of the dry regions of the west) wherever there are swampy places. Here the beetles may be found at all seasons of the year—in the warmer season in the swamp, in winter time under old leaves and other shelter in drier places near the swamps. The beetle is just as much at home under water as out of it, though not surrounded by an air-bubble, as in Hydrophilidæ, Elmidæ, Psephenus, and others. It appears probable that it carries its supply of air between abdomen and elytra, the slow respiration peculiar to most Rhynchophora no doubt enabling it to remain for a long time in its watery element without renewing this air supply. It evidently feeds on a great variety of plants, having been actually observed to feed on Sagittaria, Scirpus, Cyperus, Nymphæa, and Nuphar, besides wild and cultivated rice.

The shape of the "maggot" is different from that of the ordinary Curculionid larva, and it resembles much more the larva of a Cerambycid, or "Long-horn beetle."

In fact, from its shape, we originally took this view and supposed it might be the larva of *Spalacopsis suffusa*.* The pupa we have not studied.

*This species has meanwhile been bred by Mr. Hubbard while on a trip on Indian River, Florida, from the stems of *Chenopodium anthelminticum* (Jerusalem Oak), which harbored, also, numerous larvæ of *Hippopsis lemniscata*.

STRUCTURAL AND DESCRIPTIVE.

The genus Lissorhoptrus, belonging to the tribe *Erirhini*, is at once distinguished from the numerous genera composing that tribe by one character not otherwise occuring in this and allied tribes of Curculionidæ, viz., the smooth and shining antennal club which is annulated only at the outer third. The deceptive resemblance we find so often in Rhynchophora between species of different, and often widely separated, genera is well illustrated in our species, as without examining the distinguishing generic features it is hardly to be distinguished from a small *Bagous*, and still less from *Onychylis nigrirostris* Boh. It was originally described by Say (Curcul., 29; ed., Le Conte, I, p. 297) as *Bagous simplex*, and Dr. Le Conte founded, in 1876, the genus *Lissorhoptrus* upon this and a second species, the *Notiodes apiculatus* Gyllh. Both species very closely resemble each other, the only differences—the usually larger size of *apiculatus* and the transverse lateral impression on the thorax of *simplex*, which is wanting in *apiculatus*—being hardly of specific value.

The following description will illustrate the general appearance of our species, though as already stated the smooth antennal club is the most important character for the distinction of the species:

LISSORHOPTRUS SIMPLEX.—*Imago.*—Average length from tip of thorax, 3^{mm}. Oblong-oval, covered with large, dirt-colored scales, but usually entirely enveloped in an argillaceous coating, which renders scales and sculpture irrecognizable. Rostrum stout, as long as head and thorax, subcylindrical, densely rugosely punctulate, neither sulcate nor carinate; head densely punctulate. Thorax as long as wide, constricted anteriorly, lateral lobes well developed, sides moderately rounded, base truncate, a finely impressed median line, surface densely rugosely punctate, sides at middle with a shallow transverse impression. Elytra much wider at base than thorax and about twice as long; humeri oblique, strongly declivous at apex, punctate-striate, interstices wide, subconvex, 3d and 5th more prominent at declivity than the rest. Prosternum flattened, transversely impressed in front of coxæ; abdomen coarsely punctate. Tibiæ somewhat curved, armed with a strong terminal hook; tarsi narrow, third joint not emarginate; claws slender, approximate.

Larva.—Length when full grown, 7^{mm} (a little more than a quarter of an inch). Straight, slender, tapering very gradually from second thoracic joint to end of abdomen; footless; on the dorsum of each of joints 5–10 is a pair of movable, pale-brownish thorns, the apical ends of which are split and somewhat resemble true claws. General color white; mouth-parts brown. Head rounded, convex, corneous; upper surface smooth, without hairs; Y-shaped suture distinct; anterior border sinuate on each side, broadly arcuate in the middle. Ocelli two on each side, the first near the anterior border of the head, behind the insertion of the mandibles, consisting apparently of a group of three minute pigment cells beneath the surface of the head, at the base of a bristle; the second a short distance behind and above the first, consisting of a very minute single pigment cell. Antennæ scarcely visible as minute tubercles upon the anterior border of the head near the angles of the clypeus. Clypeus separated from the front by an impressed line, transverse, narrowed anteriorly, broadly emarginate at apex. Labrum short transverse, bearing bristles in front. Mandibles broadly triangular, obscurely bidentate, molar surface concave, not prominent. Maxillæ prominent, broadly triangular, moderately thickened, with two or three bristles on the under surface; terminating in a two-jointed palpus and a short triangular connate lobe; the first joint of the palpus as broad as long, terminal joint cylindrical, elongate, projecting beyond the mandibles; the lobe bearing inside five or six curved spines. Labium consisting of a very large triangular mentum and a cordiform palpigerous piece. Labial palpi divergent, the basal joint tuberculous, the terminal joint elongate, conical. No distinct ligula is visible between the widely-separated labial palpi.

Thoracic joints transverse; the first longer, truncate, conical; the second and third equal in length to the following abdominal joints, and slightly exceeding them in width. The first 8 abdominal segments subequal in length, gradually decreasing in width posteriorly, the second to the seventh bearing above a transverse oval prominence, each surmounted by a pair of short spines curving forward; the terminal ninth segment short, obtusely conical, without anal prominence.

A single pair of spiracles only is discernible; these are placed upon the sides of the prothoracic joint just above the lateral prominence.

The sides of the body present a double line of prominences, beginning upon the first thoracic joint as a single longitudinal fold, which, upon the nine following joints, divides longitudinally into an upper and lower fold, rising into tubercles upon each joint. The upper row of tubercles decrease and the lower row increase in prominence from the anterior to the posterior segments; the two terminal segments have each a single lateral fold.

The body of the yellowish-white larva is cylindrical, somewhat thickened anteriorly, and curved backward in the form of a letter J, without visible hairs or trace of prolegs. The head is capable of being retracted into the prothoracic joint.

Descriptions of Curculionid larvæ are few in number, and a comparison of this with its nearest relatives is not at present possible. Except in its peculiar curvature, the reverse of that seen in most Rhynchophorous larvæ, it does not probably deviate widely from the normal type. From the larvæ of *Baridius vestitus* Schönh. (Candèze, Histoire des Metamorphoses de quelques Coléoptères Exotiques, p. 48, pl. IV, fig. 3) the larva of Lissorhoptrus differs notably in the form of the mentum, the absence of abdominal spiracles, the presence of ocelli, the distinct Y-suture of the head, and the dorsal recurved spines.

THE RICE STALK BORER.

(*Chilo oryzæellus*, N. Sp.)

Order LEPIDOPTERA; family CHILONIDÆ.

[Plate VII, Fig. 1.]

HABITS AND NATURAL HISTORY.

This species, the larva of which was found boring rice stalks last summer, is now publicly mentioned for the first time. The moth is handsome and is generically allied to the species which in the larva state similarly infests the stalks of sugar cane and corn.

Mr. Howard, in the report of his observations at Savannah, writes as follows of this insect:

I noticed while passing through the rice fields that many of the rice heads were dead and white. I learned that this appearance was known as "white blast," and that the popular explanation of its cause was "poison of the soil." Such an explanation, however, would not account for the dying of one stalk in a bunch, as was almost invariably the case, so I immediately suspected insect work. I examined several of the blasted heads without finding any satisfactory cause, the head seeming dead from the base of the grain cluster, but below that point the stalk appearing sound. I soon, however, found a stalk where at the first joint below the head, concealed by the sheath of the leaf and inside the stalk, was working a very minute Lepidopterous larva, whitish in color and striped longitudinally, with two subdorsal stripes of reddish-brown. Soon after I found other larger larvæ of the same species lower down in the stalk, and at last reached a spot at the intersection of two ditches, where I found full-grown larvæ an inch long, quite at the base of the stalk, and also one or two healthy pupæ. In these cases the stalk appeared dead quite to the roots, all the leaves being brown and withered. I was told at first that this borer was quite new to the planters, and I therefore studied it with a great deal of interest; later, however, I was informed that it had been observed before. In perhaps one-fifth of the stalks afflicted with the blast this larva, either large or small, was found. I never found more than one full grown individual in a stalk, but frequently found from one to six or eight young ones. All sections of the stalk seemed equally liable to be infested, the smaller larvæ being usually found nearer the head where the stalk is smaller, while the larger individuals from necessity were found lower down.

The larva, as it increases in size, does not, however, continue its burrow down the center of the stalk to roomier quarters, as it might easily do, but apparently, when the stalk becomes too small for it at any one point, it bores its way out through a circular hole and crawls down the outside of the stalk to a lower point and enters again. The holes of exit and entrance are usually hidden, except at the very base of the stalk, by the clasping base of a leaf, the larva being obliged apparently to work its way into this tightly-fitting crevice in order to get sufficient purchase to bore through the hard stalk.

There seems little enough for the larva to feed upon in the stalk, and it only eats the layer lining the stalk cavity. I have seen a larva passing from one stalk to another, though I doubt whether it is customary for a single larva to destroy more than one stalk in the course of its growth.

When a larva is ready to transform (it is then at the base of the stalk) it continues its hole of entrance through the inclosing leaves, making it at the same time larger. It then returns to a higher position in the stalk (from one to two inches above the aperture) and transforms without reversing its position, and with its head away from the opening. The duration of the pupa state is not more than 5 or 6 days. No observations have yet been made on the eggs, but they are probably laid on the upper leaves close to the stalk.

There is no evidence of an earlier brood in the cultivated fields, as every burrow examined contained either larvæ, pupæ, or fresh pupa skins at the time that harvest had already commenced. In the volunteer rice, however, another brood is probably developed.

The duration of the pupa state varied in our vivaria from seven to twelve days, and the moths issued from August 20 to September 5. The moth is of a very pale-yellowish or straw-yellow color, with golden cilia to the front wings, a few golden scales scattered over the disk, and a series of seven black dots on the hind margin. It has an average expanse of a trifle more than an inch (27^{mm}).

ENEMIES.

Dipterous larvæ were found destroying a pupa inside the stalk, and in a single instance there has been bred from them *Phora aletiæ* Comstock, a fly whose larvæ were supposed to be parasitic, but which seem to be more scavengers than parasites.

PREVENTIVE MEASURES.

The borer, in the fields Mr. Howard examined, occurred in about one-fifth of the blasted stalks. It was sufficiently abundant, in fact, to make its destruction a matter of some importance. The later brood, if there is one, must take to the volunteer rice around the edges of the fields, or to the large grasses growing upon the embankments, though none were found in such. It is the custom, some time during the winter, to burn the stubble over the entire plantation. Great care is however taken not to allow the fire to reach the trash near or upon the embankments, as the soil of which these are made is of such a character as to burn readily, and their bulk would be greatly reduced by such a burning. Instead, then, of burning the weeds and volunteer rice along these banks they are simply cut. It is probably here that the insect hibernates, either as larva or pupa, and it will be necessary to cut most carefully the wild rice and grass close to the ground and carry it to some safe place where it can be thoroughly burned.

STRUCTURAL AND DESCRIPTIVE.

We have had some difficulty in deciding as to the true specific determination of this insect, chiefly because of a close general resemblance which it must possess to other species. Mr. Grote, when we showed him a specimen last autumn in New York, thought it might possibly be his *Chilo crambidoides*, while Professor Fernald determined it from a specimen which we sent him as *Diphryx prolatella* Grote,* stating at the time that he might be wrong, but that, having seen Mr. Grote's type, he considered our insect identical with it so far as he could trust his recollection. The specific description of *D. prolatella* certainly does agree very closely

*N. Am. Moths, Bull. U. S. Geol. Survey; VI, No. 2, p. 273.

with the species we are considering, which has also the mucronate clypeus of *Diphryx*, but in order to refer our insect to *D. prolatella* we must assume that Mr. Grote erected his new genus, *Diphryx*, on a mutilated specimen which had lost its maxillary and part of its labial palpi, for the genus is founded on short labial papi which hardly exceed the face, and the absence of maxillary palpi—characters decidedly exceptional and remarkable in the family. In order to settle the matter, therefore, we again referred, through Mr. Henry Edwards, a perfect specimen to Mr. Grote, who upon this second more careful examination decides that it is neither of the species mentioned but an undescribed species of *Chilo*. It is in fact, as we have always felt, congeneric with the larger sugar-cane and corn borers treated of in the last annual report of the Entomologist (pages 240–245) under the generic name *Diatræa*.

The characters of the genus *Chilo* of Zincken-Sommer, are given by Heinemann as "Male antennæ but little longer than those of female. Palpi long, projected horizontally, compressed. The hind mid rib of hind wings with long hairs. Abdomen of female without terminal tuft." Zeller, more recently,* adds to the few characters of the genus, the long abdomen, especially of the female, which extends much beyond the inner angle of the hind wings; he also mentions the acute apex of primaries, the point being, however, not specially separated from the hind border. Accepting Mr. Grote's decision, since we have no opportunity of examining the type of his *Diphryx*,† we would characterize our Rice borer as follows:

CHILO ORYZÆELLUS n. sp.—*Imago*.—Expanse, 22–32^{mm}. *Male*, general color pale ochreous. Labial palpi quite bushy and slightly broadening at tip, horizontal or slightly depressed, nearly as long as head and thorax together, with numerous black scales and hairs intermixed with the paler ones; maxillary palpi quite prominent and with but a few dark scales. Primaries rather darker than secondaries, due to scattered ferruginous and dusky scales between the veins, most persistent in an oblique line from apex to just beneath and within the disc; many of these scales have a golden luster, and a more or less distinct series of such scales form a narrow, subterminal line, rounded and curving away from the apex; a series of seven black points along the posterior margin; the fringes pale golden. Under surface pale, dingy-yellow, with the seven marginal dots of primaries well indicated, and a few dusky dots showing on hind margin of secondaries. *Female* differs in being somewhat larger, in having the abdomen, the hind wings above, and the whole under surface silvery-white. The primaries have less brown about them and the labial palpi, though equally long, are less bushy, and compressed so as to be more pointed.

Described from four males and six females bred from rice culms.

Larva.—Average length, 23^{mm}. Diameter a little over 3^{mm}; abdominal joints 1–7 equal in size, the second and third thoracic joints slightly broader. Head dark brown, polished, furnished with a few stiff, brownish hairs. Cervical shield light brown, median line still paler, front margin whitish; a blackish triangular spot widening towards the lateral margin each side of medio-dorsal line. Color of body pale yellowish-white, slightly transparent, marked with four rather indistinct, pale, purplish stripes, of which those bordering the stigmata are scarcely half as broad as the others. The piliferous spots are large, oval, pale-yellowish, and polished. Stigmata small, transversely oval, brown, the last pair twice as large as the others. Anal plate yellow, polished, furnished with a row of three hairs upon each side and two near middle; it is marked with a few brownish spots. Legs yellow.

Pupa.—Length, 17^{mm}. Color, yellowish-brown; head, thorax, wing-sheaths, and stigmata somewhat darker; eyes black. Head bent forward, its front somewhat pointed. Thorax with very fine transverse striæ. Abdominal joints 5–7 armed dorsally near their anterior margin with numerous very minute brownish thorns; all joints with extremely fine granulations. Stigmata projecting. Tip of last joint rounded, with a longitudinal lateral impression; expanded dorsally into two flattened projections, each being divided into two broad teeth.

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*Horæ Soc. Ent. Rossicæ, XVI.

†As Mr. Grote's types are in London he may be mistaken even in his final opinion, and the careless manner in which he has often made other genera renders it quite possible that *Diphryx* is a myth, founded on an imperfect specimen as above indicated.

WHITE BLAST.

While it is possible that the disease known to rice planters as "white blast" may have no connection with injuries by insects, still it seems necessary to give it some little consideration here, as it may prove that insects play a most important part in relation to it. We quote, therefore, from a letter from Colonel Screven:

It is not uncommon to see a very few, perhaps as few as a half dozen, heads shoot out white or blasted in an area of 150 feet square (a rice-field half acre), especially near the water-gates, where the growth is commonly most luxuriant. Planters have long known that this is caused by a small white worm, which bores into the stalk below the head. After shooting out white these heads turn gray from exposure to the weather. Usually the damage from this cause is too trifling to call for more than passing attention; but on my place the damage was so extensive as to demand careful attention.

At first I was strongly inclined to the opinion that, while insects might unite with them, that deleterious elements in the soil were the main cause of the blast. It was evident that in many, indeed in most, instances, the blast was most conspicuous in spots where the soil was charged with salts and where the plants showed want of growth and evidences of defective or morbid nutrition. But evidently the blast could not be ascribed to bad soil, because all the heads and stalks were not affected alike in the same spot, or when generated from the same individual seed. One seed commonly produces several, sometimes twoscore heads. All of these heads form on stalks fed by roots penetrating the same soil. If like produces like, or like causes produce like results, all the heads from one and the same seed, fed from the same soil, would suffer alike if the character of the nutriment were the question. But very commonly two or three of a few heads in groups from the same individual seed, all conditioned identically the same as to soil, were blasted, while the rest were perfect or nearly so. Again, the blast occurred also in spots where the growth of rice was excellent and the soil known to be good, as at the angles of intersecting ditches where drainage would be best. Hence the blast exhibited a want of uniformity for which soil poison or defective soil would not account.

As a general fact the blast occurred in fields generally shot out, say July 25, after the harvest-water had been applied, say forty days, so subjecting the fields to the same conditions in regard to watering and kind of water (at all times drinkable by the laborers) and for the same length of time.

In the fields just alluded to the blast was confined to the margins between the main ditches and the embankments, extending sometimes to the outer edges of the main ditches, and occasionally a little along the edges of the quarter drains. But it was marked and comparatively extensive in two instances in the angles of fields. I cannot say that in these exceptions the condition of the soil would warrant blast more extensive in other parts of the same fields, apparently in the same condition.

As regards the appearance of blast upon the margin, it may be mentioned that fire is carefully avoided on my place on the embankments, in consequence of the combustible nature of the soil of which they are constructed, and that the stubble was very imperfectly burned last winter on account of its wetness, especially in the lowest part of the fields and margins where the blast showed most. But as a general thing, with the exception to be stated, the blast seemed to be associated with brackish and the least-drained soil. Whether such spots are most attractive to insects, or their ova survive there for lack of the effects of fire in attempting to burn stubble and brush, I know not. But what will explain the difference between two adjoining fields, alike brackish in location and soil—both capable of being flowed with salt water—the one generally affected by blast, the other scarcely at all?

The first of these fields was planted in April, the other in May, a month later. The growth in both was luxuriant, but the heads *first shot* in the former were blasted generally over the field.

The heads subsequently shot were large and healthy. Here again we find, on a large scale, the same want of uniformity of effect which is logically and naturally to be expected from uniformity of soil.

It was a general fact that when the blast was found the maggot was also present; but the maggot was found to be absolutely harmless in my back squares, where the soil is peaty and weak and where the blast, comparatively rare, was found exclusively on the margin. Here, also, the weevil was found.

I am safe, I think, in the opinion that as far as my observation goes on my place the blast would not be caused by ocean salts or these salts converted. In the blast from this cause the head does not shoot out white but with black spots on the husk, the leaf red at the ends and spotted black, and drying up afterwards, the grains turning finally black and remaining empty, or, if filling, with soft, dusky grain of little value. Nor in these cases are insect damages necessarily found, either from borer or from incisions.

I cannot recall any other circumstances of value, while I am thoroughly aware that the case must be one of dispute. But my conclusions are that the blast under discussion, on my place, was in the main produced by a plurality of insects—by the *borer*, which penetrated the stalk and killed the head as a rule outright, by its fly or other insect, which fed on the pollen of the flowers or cut and fed on the husks and their primary contents. To these we may add the fungus.

Mr. Howard treats the "white blast" in his report as follows:

The blast not caused by the borer presented a very similar appearance, with the exception that the heads alone were affected, the stalks below the heads remaining green and comparatively healthy. That it is due to no local peculiarity of the soil is shown by the fact that often but one stalk in a clump bears a blighted head, the remaining stalks being green and bearing normal heads. The green head first turns yellowish and then dead white, the distal end of each grain having a brownish spot. Later the head turns black, possibly from a fungus growth upon the sheaths of the seed. I spent a great deal of time in examining such heads and their supporting stalks for evidences of insect work, and although I found quite a number either on the head or in the leaf-sheath below, none were sufficiently abundant, in my estimation, to have caused the damage.

Upon nearly all of the blasted heads, where the grain had wholly or partially formed, some of the lower grains upon the head had been gnawed by some insect which had been small enough to enter the sheath. The only insect which I found which seemed capable of doing such damage was *Scymnus fraternus* Lec. I suspect this species of being the author of the mischief, although I am not certain. It was quite common upon the heads, and I found a specimen in a single instance inside the sheath of one of the injured grains. I believe this species has not yet been found to be herbivorous, and hence I hesitate to enter a formal accusation.

Upon the stalk below the head were fastened in several instances small, brown Dipterous puparia. These were sent to the Department, but beyond a Proctotrupid parasite of the genus *Cosmocoma* nothing has been reared from them.

A number of specimens of a Gamasid mite were also found upon the heads. Upon the stalk below the head, where it is inclosed by the leaf, were found several long, curved, greenish eggs, which were sent to the Department, and from which have issued a species of *Orchelimum*.*

Colonel Screven described very accurately one of these "green grasshoppers," which, he said, did much damage to the rice two seasons ago by eating the leaves. This is possibly the same species.

Some unknown crimson eggs were also found in a similar location on blasted rice.

A species of *Thrips* was found in one or two instances on the stalk below the head.

The common Chinch-bug (*Blissus leucopterus*) was also found upon the blasted heads in several cases.

From the above observations it would seem that the blast is the after effect of some insect injury earlier in the season, although no traces of extensive work either upon stalks or heads was to be seen. It may be the puncture of some plant-bug—possibly of the Chinch-bug—arresting the nourishment of the head and predisposing it to the attacks of some fungus growth, though no fungus was detected other than black patches on the husks of the grain, which were evidently a result rather than a cause of the disease.

It is possible, also, that the work of the Water-weevil earlier in the season, when it abounds, may have some influence in causing the blast. The subject is one which should be studied the whole season through in order to arrive at satisfactory results.

The plan already suggested in treating of the borer, viz., of carefully collecting and burning the trash of the embankments, would of course prove effective in destroying many of these other insects, and in so doing might have a beneficial effect upon the blast.

* Apparently the *Orchelimum glaberrimum*.—C. V. R.

OTHER INSECTS INJURIOUS TO GROWING RICE.

To the insects already treated we may add a few which are found in the rice-fields, and one or two of which may occasionally do some injury. Prominent among these is the common "Grass Worm" of the South (*Laphygma frugiperda* Sm. and Abb., see Plate VII, Figs. 4, 5). When the insect has become exceptionally numerous for some reason or other, the moths of the first or second generation fly out over the rice-fields and lay their eggs on the growing stalks. The worms hatching rag the plants badly, and, when in great numbers, eat them to the ground. In 1881, after the rice had gotten a good start, in May, the worms appeared in force upon the plantation of Mr. William Barnwell, the first plantation above "Proctor's," and did considerable damage before the first or second week in June, at which time they went into the ground to transform. Here they were imprisoned and destroyed by the harvest flooding. The injuries of the Grass Worm to rice need never be feared, as the fields can be overflowed almost at will, and if necessary the negroes can be sent through the fields to brush the worms from the stalks and leaves into the water.

The figure on Plate VII of the Grass Worm and three varieties of the moths are from our eighth Missouri Report. It is a very common insect in the vicinity of Savannah. At the time of Mr. Howard's visit a later brood was doing great damage to certain truck farms a few miles north of the city, eating the grass, cabbage, strawberry, and bean plants. The most remarkable evidences of cannibalism were noticed at the farm of Mr. John Schley, the older worms destroying the younger ones by hundreds, and when plenty of other food was at hand.

During August and later the paths and embankments around the rice-fields are almost covered by the "lubber grasshopper" (*Romalea microptera*) and an interesting black variety of the female. The numbers in which this species occurred were enormous, yet they seemed to do little damage to the rice.

The large obscure Acridium (*A. obscurum*) was very common in the fields, and other smaller species of Acrididæ were occasionally seen.

The most common Heteroptera were *Metapodius femoratus* Fabr., *Oebalus pugnax* (Fabr.), and *Leptoglossus phyllopus* (Linn.).

INSECTS AFFECTING CORN OR MAIZE.

THE CORN BILL-BUG.

(*Sphenophorus robustus* Horn.)

Order COLEOPTERA; family CURCULIONIDÆ.

[Plate VIII, Fig. 2.]

HABITS AND NATURAL HISTORY.

For many years several species of the genus Sphenophorus have damaged the corn crop in various parts of the United States, more particularly at the South, where they are all known as "Bill-bugs." Glover, in his 1854 report, spoke of their injury in South Carolina, Alabama, and Arkansas, and figured, but did not determine, the species. Walsh, in 1867 (*Practical Entomologist*, II, 117), describes a species injuring corn in New York as *S. zeæ*, but which subsequently proved to be *S. sculptilis* of Uhler. *S. sculptilis* also occurs in the South and West, and is common in Illinois and Missouri. It has also been received at the Department of Agriculture from Florida and Alabama, *S. robustus* from South Carolina, and *S. parvulus*, from Missouri, all as injuring corn.

A short account was given in the Department report for 1880 of *Sphenophorus robustus* (called *S. pertinax* by our predecessor) from accounts given by S. M. Robertson, of Dadeville, Tallapoosa County, Alabama, and of *S. sculptilis*, received from South Carolina. In 1881, rather alarming reports being received from parts of South Carolina concerning the damage done by "Bill-bugs," we sent an assistant (Mr. Howard) to investigate the injury. The larval habits of all the above-mentioned species of Sphenophorus have heretofore been unknown. Walsh surmised that *S. sculptilis* would be found to breed in decaying driftwood washed by water, the adults migrating to neighboring cornfields, and some subsequent facts that had come to our knowledge, lent weight to his hypothesis so far as this particular species is concerned.

Before proceeding further it may be well to state that the damage done by all these species is principally in early spring, as the young corn appears above the ground. Stationing themselves at or near the surface of the ground the beetles puncture the stalk and suck the sap, either killing the corn of the hill outright or dwarfing it so as to severely injure it. The leaves that shoot out later are badly ragged by these punctures. Walsh's correspondent stated that the crop of many fields in Ohondaga County, New York, was completely destroyed, and Mr. Robertson, as quoted in last year's report, stated that *S. robustus* was very destructive on the swamp-lands near the Tallapoosa River, killing the corn as late as August.

The following account is from Mr. Howard's report of observations:

The species found near Columbia, S. C., is *S. robustus*. In the plantations along the bottom-lands of the Congaree River much damage is done by the adult beetle every year, and the corn not infrequently has to be replanted several times as the earlier plantings are destroyed. The beetles are first noticed in the spring after the corn is well up. Stationing themselves at the base of the stalk, and also burrowing under the surface of the earth slightly, they pierce the stalk and kill many plants outright, others living to grow up stunted and dwarfed.

With *S. sculptilis*, in spite of the damage it has done, the earlier stages remain unknown, Walsh surmising that the larva breeds on rotten wood, so situated that it is continually washed by water. With this statement in my mind I was prepared to doubt the statement of Mr. W. P. Spigener, of Columbia, who informed me that the "grub form of the bill-Bug" was to be found in the corn, but a couple of hours in the field convinced me that he was right, my previous idea having been that he had mistaken the larva of *Chilo saccharalis* for the weevil grub. I searched a field on Mr. Spigener's plantation, which was said to be the worst point in the whole neighborhood for bugs, for some time before finding a trace of the beetle in any stage, but at last, in a deformed stalk, I found in a large burrow, about at the surface of the ground, a full-grown larva. After I had learned to recognize the peculiar appearance of the infested stalks I was enabled to collect the larvæ quite rapidly.

They were present at this date (August 20) in all stages of larval development, but far more abundantly as full-grown larvæ. A few were preserved in alcohol and the remainder forwarded alive to the Department, but all died on the way. Two pupæ were found at the same time; one was preserved in alcohol and the other forwarded to the Department. The beetle issued on the way, and from this specimen we have been able to determine the species. From an examination of a large number of injured stalks it seems evident that the egg is laid in the stalk just at the surface of the ground, preferably and occasionally a little below. The young larvæ, hatching, work usually downward, and may be found at almost any age in that part of the stalk from which the roots are given out. A few specimens were found which had worked upward for a few inches into the first section of the stalk above the ground, but these were all very large individuals, and I conclude that the larva only bores into the stalk proper after having consumed all available pith below ground.

The pupæ were both found in cavities opposite the first suckers, surrounded by excrement compactly pressed so as to form a sort of cell.

Wherever the larva had reached its full size, the pith of the stalk was found completely eaten out for at least five inches. Below ground even the hard, external portions of the stalk were eaten through, and in one instance everything except the rootlets had disappeared, and the stalk had fallen to the ground.

In a great majority of instances but a single larva was found in a stalk, but a few cases were found where two larvæ were at work. In no case had an ear filled on a stalk bored by this larva. The stalk was often stunted and twisted, and the lower leaves were invariably brown and withered.

In the field which Mr. Howard visited, not more than 5 or 10 per cent. of the stalks had been damaged. The principal injury was done early in the spring, and the hills then killed had been replanted.

PREVENTIVE MEASURES.

From the present state of our knowledge and from the fact that the beetles issue in the fall, it seems probable that the insect hibernates, as do the other Curculionids, in the beetle state and in the stalk. Both Mr. Spigener and his son, intelligent men and good observers, state this to be the case. The remedy, then, of cutting stalks in fall or early winter and of plowing up the stubble and burning it is very obvious.

In the lowlands where the Bill-bug abounds, the Lepidopterous borers are unknown, so that there will be no necessity for burning more than the stubble, which should, however, be cut high, at least 6 inches above ground, to insure the destruction of all.

Mr. Spigener turns his poultry into the corn-field in spring, but considers this a rather dangerous proceeding, on account of the "remarkable grip" of the Bill-bug; he has seen them cause chickens great distress by gripping the throat as they attempt to swallow them.

The testimony of Mr. Spigener just given, relative to the hibernation of the adult beetles in the stalks, is corroborated by the experience of Mr. S. M. Robertson, as reported to the Department. This gentleman stated that upon examining the stalks during the winter time fully 50 per cent. of the stalks were found to contain the beetles in the tap-root, alive and healthy, notwithstanding the extreme severity of the winter. In one field, which was completely under water for six days during January, they were found to be as abundant and apparently as healthy as in those fields which remained above water. With regard to remedies, while the beetles are actually at work in the spring upon the young corn, the dusting with some arsenical poison, such as Paris green or London purple, mixed with some diluent in the proportions we have so often indicated, would probably be effective in destroying many beetles while in the act of gnawing their way into the stalks.

With regard to preventives, a most perfect one will be found as already indicated in pulling up and burning the stubble during the winter, or preferably as early as possible after harvest. With reference to this remedy Glover says: "A very perceptible decrease of the Bill-bug has been observed where the practice of burning the roots has been followed, and, if persevered in, might nearly eradicate them in the course of a few years."

STRUCTURAL AND DESCRIPTIVE.

The distinguishing generic characters of *Sphenophorus* may be briefly given as follows: Side pieces of metasternum rather narrow; epimera of mesosternum externally truncate (not acute); front coxæ narrowly separated by the prosternum; third joint of the hind tarsi either glabrous or only pubescent at the sides. A peculiar external appearance will render the genus at once recognizable to the experienced eye, while the numerous species are very difficult to distinguish. The form of the tibiæ and tarsi and the vestiture of the latter have furnished excellent characters to divide the genus into natural groups. That to which our species belongs is characterized as follows: Tibiæ all rounded (not truncate) at outer apical angle; third joint of hind tarsi conical (not broadly dilated); third joint of anterior and middle tarsi feebly dilated and spongy pubescent at the sides.* Of the five species constituting this group, two are easily known by the third elytral interval strongly elevated at basal third; the third species (*S. costipennis* Horn) has the elytral intervals alternately subcostiform in their entire length, and the thoracic smooth lines parallel and equal. The two remaining species, *S. pertinax* Oliv. and *robustus* Horn, are so closely allied that Dr. Horn himself, in describing the latter species, says:† "It is with considerable diffidence that I venture to name the present form." *S. pertinax* is much more common than *robustus*, and has long since been known as greatly injurious to corn, though its earlier states have never been described. The differences between the two are very slight indeed, and hardly entitled to specific value; in *pertinax* the median thoracic vitta is more suddenly dilated and more narrowed toward the base, the elytral intervals feebly alternating in width and convexity, while in *robustus* they are equal.

Omitting characters of minor importance, and those peculiar to the group (already mentioned above), we would give the following short diagnosis of our species:

SPHENOPHORUS ROBUSTUS.—*Imago.*—Black, moderately shining beneath, upper surface covered with ochreous subsericeous exudation (which, however, is very easily rubbed off, the beetle then appearing of a dirty-black color); thorax with three feeble, smooth, longitudinal vittæ of unequal width, the intermediate one feebly dilated at middle and attaining the base with its broader posterior end; elytra finely striate, the intervals flat, subequal, not alternating in width and convexity.

Larva.—Length 12 mm; color, dingy white; head chestnut-brown, with four vittæ of paler color, two upon the occiput, converging towards the base, and one along each lateral margin; trophi very dark, clypeus paler; body fusiform, strongly curved, swelling ventrally from the third abdominal joint posteriorly, slightly recurved and rounded at anal extremity. Head large, oblong, obtusely angulate at base, sinuately narrowed anteriorly; frontal margin with a shallow emargination between the mandibles; upper surface with a median channel, the occipital portion deeply incised, with raised edges, continuing as a shallow impressed line to the middle of the front; on either side an engraved line, commencing upon the vertex, becoming deeper after crossing the branches of the Y-suture, and terminating at the frontal margin in a bristle-bearing depression; front with four additional bristle-bearing depressions; sides and vertex with several long bristles arising in depressions; antennæ rudimentary, occupying minute pits on the frontal margin at the middle of the base of mandibles; ocelli a single pair, visible only as translucent spots upon the anterior face of the thickened frontal margin, outside of and closely contiguous to the antennæ from which they are separated by the branches of the Y-suture, a few pigment cells obscurely visible beneath the surface; clypeus free, transverse, trapezoidal, with faint impressions along the base and at the sides; labrum small, elliptical, bearing spines and bristles, a furrow each side of the middle, forming three ridges, so that the organ, when deflected, appears three-lobed; mandibles stout, triangular, unarmed, with an obsolete longitudinal furrow on the outer face; maxillæ stout, cardinal piece transverse, basal piece elongate, bearing a palpus of two short joints, and a small rounded lobe, furnished

*For the classification and systematic arrangement of *Sphenophorus* and its species we refer the reader to the following papers: Dr. George H. Horn, *Contributions to a Knowledge of the Curculionidæ of the U. S.* (Proc. Amer. Philos. Soc., 1873, pp. 407–420), and Dr. J. L. Le Conte in *The Rhynchophora of America north of Mexico* (*l. c.*, Vol. XV, 1876, p. 330.)

† *L. c.* p. 419.

at tip with a brush of spiny hairs, the lobe concealed by the labium; labium consisting of a large triangular mentum, excavate beneath, and a hastate palpiger, with a deep median channel; labial palpi divergent, separated by the ligula, of two joints subequal in length; ligula represented by a prominent rounded lobe, densely ciliate on the under surface. Thoracic joints separated above by transverse folds; the first wider, covered above by a transverse, thinly chitinous plate; the two following similar to the abdominal joints; abdominal joints forming on the dorsum narrow transverse folds, separated by two wider folds, the anterior fold attaining the ventral surface, the second fold confined to the dorsum, eighth and ninth abdominal joints longer, excavate above, without dorsal folds; beneath, the first three joints contracted, the succeeding joints enlarged, the terminal joint broadly rounded, with anal opening upon a fold at its base; sides of each joint presenting numerous longitudinal folds; stigmata very large, nine pairs; the first on the anterior margin of the prothorax, low down upon the sides; the remainder upon the sides of the first eight abdominal joints, above the lateral prominences, beginning upon the first joint at the middle of the side and gradually rising to a dorsal position upon the eighth joint; thoracic and last abdominal pairs large, oval; the intermediate pairs smaller, elliptical; all with chitinous margins of dark-brown color. The noticeable features of this larva are its cephalic vittæ, and conspicuous spiracles.

The larva of the closely allied *Rhodobænus 13-punctatus* Ill. (undescribed) has a more slender form; the anal segment is protuberant, armed with two blunt terminal spines; the head is broadly rounded, not vittate, mandibles bidentate, ligula emarginate, not ciliate; the ocelli occupy the same relative positions upon the front margin as in *Sphenophorus*, but are larger, convex, lenticular, with pigment spots plainly visible beneath. In all other respects the two larvæ agree very closely, even to the folds of the body-joints and position of occipital depressions and bristles.

The larva of *Rhynchophorus Zimmermanni* Fabr. (Candèze, Hist. des Métam. de q. Coléopt. Exot., p. 51, Pl. IV, Fig. 1) agrees in general form of body and trophi, but the mentum is quadrangular, the labrum distinctly trilobed, and the abdominal spiracles wanting. (See Horn:—Trans. Am. Ent. Soc. VII, p. 39.)

Pupa.—Average length, 17 millimeters. Stout, rostrum reaching between first pair of tarsi. Antennæ, but slightly elbowed and reaching not quite to bend of anterior femora and tibiæ. Eyes scarcely discernible; face with three pairs of shallow tubercles, the basal pair the largest, and each giving rise to a stiff, brown hair. Other minute piliferous tubercles, especially near the posterior dorsal border of the abdominal joints, being very stout on the pre-anal joint, or pygidium, where they form two series of quadridentate ridges.

THE SMALLER CORN STALK-BORER.

(*Pempelia lignosella* Zeller.)

Order LEPIDOPTERA; family PHYCIDÆ.

[Plate VII, Fig 3.]

PAST HISTORY.

This new corn pest was first received by us in the latter part of July from Mr. A. C. Walker, of Richmond County, Georgia, through the commissioner of agriculture of that State. Mr. Walker stated that the insect was doing great damage to both young and old corn, and that on ten acres of corn he had just gathered two wagon-loads of stalks which had fallen to the ground from the work of this insect at the roots.

In the latter part of August we sent Mr. Howard to study it at Atlanta, Ga. and Columbia, S. C., and in September and October it was studied at Atlanta by Prof. Barnard.

Accounts differ slightly as to the length of time for which this pest has been known in South Carolina and Georgia, but none place it farther back than 1878. It seems to have appeared first in Northern Georgia, and in the latter part of 1881 it was found as far north as Chapel Hill, N. C., by Prof. J. A. Holmes, of the State university at that place. So far we have only received it from the three States of North and South Carolina and Georgia. It is remarkable that an insect so numerous and destructive as this proved to be in those parts of the South mentioned should have remained hitherto unrecorded, and this and similar irruptions of injurious insects, not observed or recorded before, has led us to some speculations as to their meaning.*

HABITS AND NATURAL HISTORY.

While chiefly injurious to young corn, destroying many stalks and necessitating the replanting of many hills, the Smaller stalk-borer works throughout the entire summer and fall, and, as late as October, cuts the toughened stalks of the late corn to such an extent that they are easily blown to the ground, and the ears are often rendered useless by contact with the wet earth. The principal work of the borers is done at the surface of the ground, although they are often found just above or below this point. They bore through the stalk in every direction, sometimes entirely severing it, more often weakening it, so that the slightest gust of wind blows it to the ground. From six to fifteen of the larvæ are usually found in a single stalk. The borers are extremely active, and retreat with great rapidity into their burrows upon the slightest disturbance.

Their operations on the stalk when young are principally below the surface, their attacks being confined to the outer crust, which they sometimes completely girdle. They generally commence to work between the rootlets, whereby these are also often girdled and die in consequence; this injury to the outer surface of the root-stalk extends, occasionally, as far down as the depth of two inches. After the worm has attained about half its size it bores into the stalk, also below the surface, generally above and very close to one of the rootlets, in a more or less straight line, until it reaches the opposite hard parts, or it works gradually upwards, widening the channel more and more, until sometimes there is formed a large cavity, leaving only the rind of the stalk untouched. The nearly full-grown larva seems to prefer to work just above the surface of the ground, and may often be found in company with the larva of *Diatræa sacchari* (Fabr.). When ready to transform, it leaves the stalk and spins a delicate, though tough, white, oval, somewhat flattened cocoon, which is completely covered with earth or excremental pellets. It is usually found in a shallow depression on the surface of the ground, so that it is extremely difficult to distinguish it from its surroundings.

The moth issues in about ten days after the larva has transformed to pupa. It has the singular habit of feigning death, and is not readily disturbed. The corn or other object upon which it may be resting can be handled quite roughly, and it even allows itself to be touched, when it will either remain in position, or will only move for a short distance, and will rarely attempt to fly. If, however, the corn on which it rests be shaken too suddenly, it will drop to the ground, draw the legs and antennæ close to the body, and will remain in this position motionless for a considerable length of time, even if quite roughly moved about. It rests in an upright position with the wings close to the body with their tips on the corn; the antennæ are laid backward on the dorsum and are not readily seen. Its flight is quite swift but of short duration.

This insect appears to be at least two-brooded in the Southern States,

*See "New Insects Injurious to Agriculture." *Am. Nat.*, Feb., 1882, p. 151; Proc. Am. Ass. Adv. Sc., Vol. XXX.

as the first moth was bred August 4, 1881, and the moths were continually issuing as late as January 31, 1882. During this time larvæ were occasionally noticed crawling about, and one specimen which was not yet quite fully grown was seen as late as January 25. This individual belonged to a lot of larvæ collected October 28, 1881, and it would appear from these observations that the insect in its natural habitat hibernates in all three states, as larva, pupa, and adult.

PREVENTIVES.

It will be impossible to find a perfect preventive for the damage done by this insect, since it hibernates, as we have just stated, in all three states of larva, pupa, and adult. It seems extremely probable, however, that the use of the same remedy recommended for the "Bill-bug," namely, plowing up and burning the stubble, will greatly reduce the numbers of the worms. The earlier this is done the more effectual will it prove.

NOMENCLATURE AND CHARACTERS OF MOTH.

*Pempelia lignosella** was originally described by Zeller in Isis, 1848, page 883, but this description is inaccessible to us. His short characterization of the species, however, in his Beiträge zur Kenntniss d. Nordamerikanischen Nachtfalter, corresponds so exactly with the more typical forms of our Corn-stalk borer, that until further light is thrown upon the subject we must consider them identical.†

The species is, however, very variable. With the male the middle of the front wings is usually pale grayish-yellow, growing darker in many individuals. Around this light center is a brown border, intermixed in many specimens with grayish scales. In one specimen the front wings are of a nearly uniform gray. The hind wings are semi-transparent, and the under side of the front wings is dusky. With the female the front wings are often black with purplish reflections, varying to a light reddish-brown, shaded with gray.

The mouth parts of the male merit description. The maxillary palpi are three-jointed; joint 1, long and slender; joint 2, short, stout, and shaped somewhat like an acorn; joint 3, slender, curved; joints 2 and 3 covered on the inner side with very long ferruginous hairs. The labial palpi are also three-jointed; joint 1, short; joint 2, four times as long as joint 1, concave on its inner side and flexible, inclosing in its cavity when at rest the entire maxillary palpus, so that even the tip of the long tuft of hairs is rarely seen; joint 3, minute. Joints 2–8 of the antennæ form a curve and are furnished with long hairs, so that the whole appears as a single laterally compressed and tufted joint. (See Plate VII, Fig. 3.)

In the female the maxillary palpi are very small and consist of but a single tufted joint, and the labial palpi and antennæ are simple.

The range of the species is great, and Zeller records it from Carolina, Texas, Columbia, Brazil, and Patagonia.

DESCRIPTIVE.

PEMPELIA LIGNOSELLA.—*Larva.*—Length, 16^{mm}; average diameter, 2^{mm}; nearly cylindrical. The color is variable. The prevailing color of the young larvæ is pale, some-

*Zeller, in his paper on the Colombische Chiloniden, Crambiden und Phyciden, gives Blanchard's *Elasmopalpus angustellus* and his own *Pempelia incautella* as synonyms of *P. lignosella*.

†Since this was in type Professor Zeller has corroborated the determination from specimens sent him.

times almost white, changing later to a dark greenish or purplish brown. Head dark brown and highly polished, somewhat smaller than the first thoracic segment into which it can be partially drawn; cervical shield black, polished, with a pale median line, its front margin pale greenish white; abdominal segments, each with a transverse wrinkle across its posterior third, which is either of a reddish or purplish color; the anterior two-thirds of all segments very pale or almost white and marked with 9 reddish or purplish longitudinal lines; anal shield dusky, with a few indistinct darker spots along front margin; venter either light or dark-bluish green; legs pale, with a faint bluish-green tinge.

Pupa.—Length, from 9 to 10mm. Color, yellowish-brown, the sutures of all parts and the stigmata brown; the dorsal line more or less distinct and quite dark green; eyes black, large, projecting; head rounded; thorax faintly transversely wrinkled. The dorsum of abdominal segments with fine impressed punctures, ventral surface smooth; tip bluntly rounded dorsally with a low, slightly rounded circular projection, which along its posterior edge is furnished with 6 fine slender spines, having their tips curved downward.

THE BOLL-WORM ALIAS CORN-WORM.

(*Heliothis armigera* Hübn.)

Order LEPIDOPTERA; family NOCTUIDÆ.

[Plate I and Plate XII, Fig. 1.]

INJURY TO CORN IN 1881.

The autumn of 1881 was rather remarkable in economic entomology from the excessive injury to corn in the more northern States by this insect. The species is one of the most widespread and injurious of the farmers' pests, and, as we have treated of it rather fully in the forthcoming fourth report of the United States Entomological Commission as an enemy to the cotton plant, we repeat in advance what we have there said upon its food-plants, other than cotton, and add a report of observations upon it made under our direction by Judge Lawrence Johnson, of Holly Springs, Miss. We also reproduce a colored plate prepared for the Commission report.

FOOD-PLANTS OTHER THAN COTTON.

CORN.—It has for some time been supposed that the first occasion on which attention was publicly called to the fact of the identity of the Boll-worm and the Corn-worm was in Mr. Glover's report upon cotton insects, published in the Patent Office Agricultural Report for 1854, where he gives the credit to Col. B. A. Sorsby, of Columbus, Miss., in the following words:

There is a striking similarity between the Boll-worm and the Corn-worm in appearance, food, and habits, both in the caterpillar and perfect state, which leads to the supposition that the Boll-worm may be the young of the Corn-worm moth, and the eggs deposited on the young bolls as the nearest substitute for green corn, and placed on them only when the corn has become too old and hard for their food. Col. B. A. Sorsby, of Columbus, Miss., has bred both insects and declares them to be the same; and, moreover, when, according to his advice, the corn was carefully wormed on two or three plantations the Boll-worms did not make their appearance that season on the cotton, notwithstanding on neighboring plantations they commit great ravages.

It is naturally desirable that so important a discovery as this should be rightly credited, and it was therefore with considerable interest that we read the following paragraph in the article on the Boll-worm in the

American Cotton Planter for July, 1850, by Mr. J. W. Boddie, of Jackson, Miss., from which we have already quoted:

This insect is an anomaly in the natural history of insects, for it is much more destructive to the plant, cotton (*Gossypium*), for which it was never made, than to the one to which it naturally belongs, corn (*Zea mays*).

If I am right in my supposition, this insect is the caterpillar we find in the end of ears of corn, eating the silk and some little of the corn. This insect is at the North as well as at the South—in fact it is wherever the corn grows and will never depredate on the cotton plant save through necessity.

The same fact of the identity of the two insects was subsequently independently proven and published by Dr. J. H. Zimmerman in the *American Cotton Planter* for 1855, Mr. E. Sanderson, in the same journal, for 1858, and by the writer, in 1864, in the *Prairie Farmer Annual*. The first time Mr. Glover expressed his belief in this identity was also in 1864, the previous demonstrators all having been Southern planters.

Sufficient has already been said in the introduction concerning the destructiveness of the Boll-worm to corn, and there remains to discuss here only its methods of work. In the North there are normally two broods which feed upon corn and exceptionally three. The first brood occasionally makes its appearance early enough to feed upon the staminate flowers, or "tassels," before the ears are formed. Instances of this are recorded by Mrs. Mary Treat, of Vineland, N. J., who writes to the *American Entomologist*, August 25, 1869, as follows:

The other day I passed a large field of corn where the depredations of this worm were visible upon almost every stalk. They had done their work weeks before, eating through the leaves while they were folded around the staminate flowers before the ears had begun to make their appearance.

It is probably the second brood which attracts the most attention and does the most damage. In August and September the infested fields begin to present a sorry sight. Many of the husks are seen to be pierced by circular holes, and upon opening, the grain is found to be eaten in furrows, principally at the outer end of the ear. If the work has been done before the kernel has set or hardened, the milky juice will have exuded and smeared the end of the ear, when mold soon forms upon it, other insects work their way in and feed upon it, and the whole ear soon presents a disgusting appearance.

Rarely more than one full-grown worm is found in the ear at the same time, though frequently several of different sizes are to be seen. In the course of its growth the worm by no means confines itself to a single ear. As the whim seizes him, or as the flavor of one ear palls upon his delicate appetite, he leaves it and enters another either upon the same or an adjoining stalk. The journey from one to another is made in the night, and the new ear is usually entered by a circular hole bored through some part of the husk; so that the mere presence of a hole in the husk does not, as is thought by many, necessarily imply that the worm has left the ear to transform.

From the first to the last of September the worms of this second brood bore out through the husks and enter the ground to transform, those pupating first frequently, in warm seasons in the more northern localities, and always, we believe, in the latitude of South Illinois, Missouri, and Virginia, giving rise to a third brood, which feeds upon the hardened corn if more congenial food is not at hand.

It was formerly thought that the efforts of the worm on corn were confined to the tender and milky ears. In fact we stated (*American Entomologist*, I, 1869, p. 212) that—

The worm cannot live on hard corn, and it is usually full-grown when the kernels are in the "milk" state.

In 1870, however, we corrected this idea in the following words (see Third Missouri Entomological Report, 1870, p. 104):

I was formerly of the opinion that this worm could not live on hard corn, and it certainly does generally disappear before the corn fully ripens, but last fall Mr. James Harkness, of Saint Louis, brought me, as late as the latter part of October, from a corn-field on the Illinois bottom, a number of large and well-ripened ears, each containing from one to five worms of different sizes, subsisting and flourishing upon the hard kernels.

Prof. E. W. Claypole, of Antioch College, Yellow Springs, Ohio, also called attention to the same fact in the November, 1880, number of the *American Entomologist*. He says:

In cutting my own corn yesterday I found many specimens of this insect, and there now lies before me an ear almost uninjured and nearly dry, the kernels being too hard to yield to the nail, and full of meal when broken, in which is an almost full-grown worm engaged in eating these hard grains. * * * Later. I have as late as the first week of this month (October) found small Corn-worms, not more than half an inch long, engaged in eating the ripe ears of corn, and I can add from experience that these small worms can bite sharply.

Last fall (1881), in the vicinity of Canton, Ill., Prof. Barnard observed that much damage was done to late corn, over two-thirds of the ears harvested having contained one or more worms. Live worms were found in the ears up to the time of husking, in the latter part of October, feeding upon the hard kernels. The ears thus damaged exhibited on husking many shallow grooves through the tops of the kernels, which seemed, indeed, the favorite mode of work of the worms; but occasionally a single kernel would be eaten down to the cob. There, as elsewhere, mildew had served to greatly increase the damage done by the worm.

In the Southern States there are always three broods of the worm upon corn, the later broods preferring the tender cotton bolls to the tough corn. The moths in early spring lay their eggs on the leaves of the corn, and the newly-hatched larvæ begin feeding at once on the spot of their birth. By these young larvæ many irregular holes are eaten through the tender leaves, giving them, as has been well said, the appearance of having been riddled by a charge of small shot. In this manner they feed for some time, gradually working their way downward into the sheath of the leaf, and finally reaching the closely-rolled terminal bud, into which they bore and remain feeding until they attain their full growth, when they gnaw directly outwards and, crawling into the ground, transform to pupæ.

The eggs of the second brood are laid upon the leaves and upon the sheaths of the tassels about the 1st of June. The worms feed, as before, upon the leaves at first, upon the tassels, and later, as they approach full growth, they are to be found feeding upon the kernels, silk, and cob of the forming ears.

The third brood, commencing shortly after the 1st of July, may be compared in its destructiveness to the second brood at the north. It is very numerous, and is the last brood which injures corn to any extent. The eggs are laid upon the end of the husk or amongst the silk, and the worms work in the manner previously described, occasionally piercing the husk and migrating from one ear to another, although the tendency to do this is much less when the ears are tender than after the grains have begun to harden. The worms of this brood pupate in the usual way, and those of the next betake themselves almost exclusively to cotton. Occasionally a worm is found working in the ears of hardened corn in close proximity to a cotton-field, but it is a comparatively rare occurrence.

TOMATO.—Perhaps next in importance to the damage done to cotton and corn comes that done to the tomato crop. In 1867 the Boll-worm played havoc with the tomatoes of Southern Illinois, eating into the green fruit and causing it to rot. (See *American Entomologist*, I, 212). In his report for 1870 Mr. Glover speaks especially of the damage to this crop the previous year in Maryland. The worm bored into both the ripe and unripe fruit of the tomato, rendering it wholly unfit for use. It was said that a single caterpillar would ruin a number of the fruit on one plant alone.

Mr. Crane, of Mandarin, Fla., an extensive vegetable grower, lost, in 1878, one third of his crop of tomatoes through this Heliothis.

Prof. J. E. Willet, of Macon, Ga., in correspondence with the Department in September, 1879, related the interesting fact that in the vicinity of Macon, at least, the Boll-worm had developed the mischievous habit of boring into the tomato-stalks until they were nearly or quite severed, thus doing more damage than it could have done by confining itself to the fruit. The larvæ have also been found feeding upon the leaves of tomato, at Washington, by Mr. Pergande, one of our assistants.

The Boll-worm has also been found by J. Jenner Weir to feed upon the tomato plant in England, and we have already elsewhere commented upon the interest attaching to this fact, since the tomato is grown with such difficulty in England.*

TOBACCO, AND OTHER SOLANACEÆ.—So far as we know there has been no record of injury to tobacco by the Boll worm in this country; but Mr. Ch. Goureau, in his *Insectes Nuisibles* (second supplement, 1865, p. 132), mentions the fact that it devours the leaves of this plant where cultivated in Europe.

Of other Solanaceous plants we may mention the red pepper (*Capsicum annuum*), the Jamestown or Jimpson weed (*Datura stramonium*), and the Ground-cherry (*Physalis*). The injury to peppers is mentioned by Professor French in the report of the Illinois State Entomologist for 1877, p. 102, while the observation on Stramonium was made by Dr. Barnard and Mr. Schwarz, at Selma, Ala., in August, 1880. On *Physalis* they were seen by Dr. A. Oemler, at Savannah, Ga., and we found them ruining the fruit of this plant in all parts of Kansas in 1877.

LEGUMINOSÆ.—The Boll worm is very fond of boring into the pods of Leguminous plants. The pod of the common garden pea (*Pisum sativum*) is frequently destroyed by it.†

Boll-worms were discovered feeding on the common string-bean (*Phaseolus vulgaris*) in the vicinity of Kirkwood, Mo., by Miss Mary Murtfeldt. In October, 1879, specimens were received from D. Landreth & Sons, Philadelphia, which had damaged their Lima-beans to the extent of from 3 to 5 per cent. Upon the field bean they were observed feeding by Mr. Howard, near Savannah, in 1881. With all these species of beans, and with the garden pea, the method of work is the same—the worm bores into the pod at some one point, and never leaves until the entire contents are ruined. With the common Cow-pea of the South (*Vigna* and *Dolichos*, spp.), in the pods of which Heliothis is very often found feeding, the work is frequently done in quite a different way.

American Entomologist, II, 172.

†See quotation from Mrs. Mary Treat, in the *American Entomologist*, Vol. II, p. 42. See also Glover's report of the Entomologist for 1870, p. 84; our third Missouri Report, p. 105; and report of Prof. Wm. Trelease, in the Report on Cotton Insects, 1879.

The seeds are separated by marked fleshy partitions, and, rather than pierce these partitions, the worm bores through to the outside and enters again opposite to another pea. In the same manner it infests *Erythrina herbacea*—a leguminous plant which grows wild through the South, more commonly near the coast. (See Report on Cotton Insects, Department of Agriculture, 1879, p. 296.) In Europe it is found on Lucerne (*Medicago sativa*) according to Goureau (*ibid.*), and upon the Chick-pea (*Cicer arietinum*) according to M. J. Fallou (*Insectologie Agricole*, 1869, p. 205.) In the latter case the young worms feed upon the leaves and the older ones bore into the pod.

CUCURBITACEÆ.—Among the Cucurbitaceæ several useful plants are injured by the Boll-worm. Glover, in 1870, records pumpkins (*Cucurbita pepo*), and Judge Johnson, in his report here appended, mentions melons (*Cucumis melo*) and summer squash (*Cucurbita verrucosa*). Mr. Glover, as long ago as 1855, found the Boll-worm feeding in the flowers of squash.—(Glover, 1855, p. 100).

MALVACEÆ.—Professor French (seventh report of the State Entomologist of Illinois) reports the worm as feeding on the growing seed-pods of the large-flowered Rose Mallow (*Hibiscus grandiflora*) along streams in Illinois. He has recently published the fact, however, that the larva concerned in this injury was not Heliothis but a Pyralid.*

The useful Okra or Gumbo plant (*Hibiscus esculentus*) is often destroyed, according to Judge Johnson, by this larva.

OTHER FOOD-PLANTS.—The families Iridaceæ, Convolvulaceæ, Urticaceæ, Resedaceæ, Geraniaceæ each contain a single food plant of Heliothis. Mrs. Treat, in her Vineland address on insects, quoted from in the *American Entomologist*, I, p. 43, mentioned the Gladiolus, grown frequently in flower gardens, as being occasionally eaten in the spring by the Boll-worm. Mr. Schwarz several times found the worm, at Selma, Ala., feeding on the green fruit of *Ipomea commutata*. He remarks: "It is a very curious sight to see this large larva with its head imbedded in the comparatively small fruit of this plant." Mr. Goureau (*l. c.*) mentions hemp (*Cannabis*) as one of the European food plants, and Kaltenbach (Pflanzenfeinde, &c., p. 42) states that the worm lives from June to August on the Dyer's Mignonette (*Reseda luteola*).

Within the last year the worms were received from Mr. Daniel Wilter, of Denver, Colo., as boring into the stems of his garden Geraniums, and also eating the leaves of the same plant.

These are, so far as we have been able to ascertain, all of the food-plants of *Heliothis armigera* yet known or at least yet recorded. Others will undoubtedly be found from time to time, and it is not improbable that the present list could be swelled into the hundreds by a diligent and specific study of this insect for a year or two, for enough has been said to show that it is a very general feeder.

In this connection we cannot avoid making the statement that the Boll-worm is by no means exclusively vegetarian in its diet, although this point will be fully discussed in the special report. It has been repeatedly known to devour the pupæ of the Cotton-worm (*Aletia xylina*) when free upon the plants, and has moreover gained a wide reputation as a cannibal, the larger individuals frequently dining upon the smaller ones.

*This statement was contained in a report prepared by Professor French for the third report of the United States Entomological Commission, but which has been independently printed in the eleventh report of the State Entomologist of Illinois.

REPORT UPON HELIOTHIS ARMIGERA. BY JUDGE LAWRENCE JOHNSON, OF HOLLY SPRINGS, MISS.

HOLLY SPRINGS, MISS., *November* 1, 1880.

In this vicinity *Heliothis armigera* (Boll-worm) made no appearance in cotton till the first or second week in August. Many of my observations may be of general interest and some value. It is worth notice that whilst cotton was free from its ravages so long, all the early corn in the county was infested to a remarkable degree. In the field examined by myself, which was planted at short intervals from the 15th of March to the 15th of April, and was in roasting-ear from the latter part of June, not more than three per cent. of the ears were found without at least one worm. It is seldom more than one is found. If two or three, they were apparently of different ages and sizes, and not in the same burrow or on the same side of the cob. This, in common estimation, is attributed to the instinct of the parent teaching her to deposit but one egg to the silk.

But one in the habit of observing insects soon finds instinct (if the word should not be discarded altogether) a very unreliable explanation. It is true this moth does not oviposit rapidly, and drops but one egg before her restless habits drive her to flit to another resting place; but she may come back again to the same ear. Other moths also may use the same shuck to provide a feeding-ground for their young without inquiring whether there is a tenant within or not. This is the reason why, when several worms are found on the same cob, they are of different ages. The eggs are laid by different moths at different times.

There is another fact to be noticed in accounting for the solitary habits of these worms. They are the most ravenous and cannibalistic of vegetable feeding larvæ I have noticed. Whenever in the course of feeding on young seeds—their normal nutriment—one comes to the ribs of another he eats right through and seemingly prefers meat to bread. I have seen a number so destroyed. True, I have also found contiguous burrows, and touching at some one point, both containing live worms; but upon close examination I am satisfied the aggressive caterpillar reached the older burrow at a point filled only with *débris*. The first having passed on, of course he turned to more inviting pasturage.

This July crop of Heliothis found in early corn, and called the first crop, is not strictly such. As in case of many other insects, the period of development in the pupa state is irregular. They hibernate in this form, and come forth from the ground in the spring, at the return of reviving heat. Their first appearance deserves more attention and closer observation. They attack the first thing that bears seeds and pods. They might well be named seed-eaters or pod-eaters, for before corn is in silk they will scarcely allow a young squash or a young tomato to escape. But it is true their main force is reserved for the young corn—and not the earliest, that is, the very earliest—for the corn of the gardens in June is comparatively free from their depredations. They reserve their main army for the regular field crops of the farmers.

The egg is laid on or near the silk, upon the shuck—as often described by others—and in about three weeks the worm has run its course; he cuts his way through the enveloping leaves and drops to the ground, which he enters to a depth of three or four inches—in some cases, if the soil is favorable—but often stops within an inch or two of the surface. I have had them to undergo the change in a box without earth, and apparently as healthful as in their normal element. The pupæ remain in the earth an irregular period. In one or two instances I have had the fly to appear within seven days, but generally ten, fifteen, and twenty days are required; and I have some of the chrysalids yet, at frost, apparently sound, which seem determined to wait for another summer.

From about the 5th to the 10th of August the moth was most abundant, and this is called the second crop. For the first time now did they appear plentifully in the cotton-fields, but no more to leave them till frost, with a noted falling off, however, about the 15th of September. In this latitude, then, it is the month from the middle of August to the middle of September that Boll-worms are to be feared, and this is exactly the period they do most damage to cotton. It is a mistake to look for their work only on the large or half-grown bolls. This popular error originates in the fact that only such remain on the stalks after injury. Even the most intelligent farmers rarely notice that the fallen bolls and young squares (as the unblown buds are called), which are shed so plentifully at this season, are, in nine cases out of ten, injured more or less by this worm. The very young do most of it. I do not deny that atmospheric influences may have something to do with the shedding of cotton, as it is called, but from a careful watching of several small fields this season I am forced to the conclusion that most of this loss is due to insects. There are several of the suctorial *Hemiptera* also taking part in the mischief—and sudden changes in degrees of heat or moisture may have some effect—but all the facts point, as you have explained to me in conversation, to the gnawing of Boll-worms as the principal factor in this kind of blight. In the first place the time corresponds with the greatest activity of these larvæ.

The farmers say the wet weather is making it shed, or the dry weather has caused it, or the cotton was ploughed a little too wet, or too dry, or too close, or too deep. They never, for a moment, suspect that the small, soft, downy, salmon-colored moths that hover about after sunset have anything to do with it.

Addressing the same common understanding, their attention may be called to the parts of the crop liable to shed (according to the style of the farmers). There are three crops to each stalk. The bottom, middle, and top crop; each of these crops of bolls, set with as many partial seasons or summer rains. The bottom crop never sheds. It always sets the fruit and is never injured by this worm, except when occasionally a grown boll is bored, or, more frequently, gnawed a little and left to be attacked by rot later. The middle crop, at the advent of this enemy, is going out of bloom, and in the very condition the young worms love most. A boll less than the size of a pigeon's egg, eaten ever so little, dies, and generally drops off. Larger than that it may live a long time and seldom falls off whether it dies or not. It is here alone that the ordinary observer discovers Boll-worm work.

At this period the top crop is in the *square*, as the unblown bud with its involucre is called—the very stage for the nourishment of the newly-hatched worm—and it is here that the great majority of the eggs is laid. What are the consequences? Whenever Heliothis is abundant a general shedding begins at the top, and extends to the middle of the crop. In two weeks the prospect may be changed ten, twenty, or even fifty per cent. A patch near me this year, carefully estimated, was changed twenty-five per cent. Generally throughout the county ten per cent. is the least calculation. Of all the injuries to cotton in this latitude none can compare with Boll-worm, for it is universal and a regular annual visitor. Once in eight or ten years Aletia takes a crop, and occasionally Rust breaks out and sweeps off a patch. Heliothis is found every year and in almost every place.

IS IT THE SAME AS CORN-WORM?—Again, it will need no closer observer than the ordinary farmer to weigh these facts and to notice a few more very manifest. For instance, it is always near corn that Boll-worm is worst; it is generally where cotton succeeds corn or cotton that they abound, and worst of all where corn is planted through a field of cotton to fill up missing places. But it is easy to settle the question by rearing the worms, as I have done this summer, collecting them from different sources and giving them a variety of food.

There are at least three varieties; all of them seem to feed without hesitation on corn (in every stage, from bloom till harvest), on cotton bolls and squares, on the green pods of beans and cow-peas, and do not hesitate to bore into okra, melons, tomatoes, and squashes. Worms taken from corn were successfully fed on cotton; and from cotton were as easily reared on corn, beans, pease, and okra. Corn in the soft stage was undoubtedly preferred to all other food, but they would eat even leaves.

The moths at this period abound, but are difficult to find in cotton during any daylight. They seem to prefer to hide in cow-peas and clover—when these grow near—and may be seen about sunset, sucking the honey secretions of flower stems of the peas and dipping into the blossoms of the clover. Yet I have never found their eggs or young in clover, and rather rarely in the cow-peas. Though almost omnivorous, Heliothid larvæ are essentially *pod-borers* and *seed-eaters*. They will take to anything having the appearance of a pod. This is curiously manifest in their preference for the chrysalids of other Lepidoptera. The larger worms would leave everything for the pupæ of Aletia when they were plentiful. This special carnivorous appetite was first noticed September 23 in company with Professor Jones, while we were experimenting in a field infested with Aletia. There were hundreds of the pupæ devoured by some enemy that broke into the larger end. Much of this work was freshly done, and when I first observed it, a few days previously, I was disposed to attribute it to a small black or dark-brown grub (supposed to be Telephorus), many of which I found in the newly-rifled chrysalids devouring the remains. But these were never in sufficient numbers to account for the destruction of the Aletia pupæ. Professor Jones, on the occasion alluded to, caught a Boll-worm in the very act, and I have since verified this propensity by finding them to prefer this diet to any other. Further observation, therefore, led me to acquit the little Telephori of initiating the robbery—they only play the jackal at the feast; the lion they follow is the Boll-worm.

TO COMBAT THE EVIL.—My experiments and suggestions may be of some value, but I have not to propose any one perfect remedy. Precautionary measures may be used with advantage, and can be easily understood by planters generally. It is evident, from what is observed as to their food and habits, that if all pod-bearing crops could be suspended a twelve-month the race would perish.* But as this is not practicable some approximation to its effects might still be obtained by judicious rotation. It is known to planters, and often remarked by them, that cotton does well after fallow, or after wheat, or any other small-grain crop. They still remember how healthy the cotton was just after the war, and how free it is from shedding in sedge land. Herein lies a lesson.

*This is altogether too broad an assertion.—C. V. R.

Heliothids, as known, pass the winter in the pupa state in the earth, in cotton and corn fields, where the full-grown worm drops. As often as possible, then, change the cropping, and never plant cotton after corn if it can be avoided; nor should it be planted near corn if the crop can be pitched otherwise. When a cotton-field becomes much polluted sow it down in wheat or oats, or plant in corn, to be followed by one of these. Green corn is the great nursery of this plague, and next to the corn is a great crop of Southern cow-peas.

The worst infested field I observed this year was a small one in which there had been a bad stand of cotton in the spring, and to mend it corn was planted in the missing places. By unskilled working more damage was done to the stand, and to mend this again cow-peas were dropped in the gaps. No arrangement could have suited *Heliothis* better. The peas supplied the moth shelter during the day, and their favorite repast at fall of evening.

Some old and formerly large and successful planters tell me that their practice to top cotton, about the 10th of August, and burn the young shoots was a check to the Boll-worm. By this practice no doubt many eggs and young larvæ were destroyed.

NATURAL ENEMIES.—Their natural enemies afford some degree of protection. Birds might be fostered, as suggested by yourself with regard to Aletia, by putting up martin boxes about in the fields. The bluebirds are fine hunters of the worms, but I have never seen them catch the moth. They will take to any kind of a box if the martins do not. These are great fly-catchers, as is well known, and fly late—the very time for crop-destroying moths of all kinds. But of all birds, the most effectual I have found are domestic turkeys and chickens. Turkeys range through a cotton-field, looking up into the leaves, and well hid must be the worm they do not find. Their value has long been known in tobacco-fields. Chickens, on the other hand, not so good after worms, are exceedingly active in pursuit of the moths. When two small fields, near me, and daily visited this summer, became naturally infested with Aletia, the last of August and first of September, the neighboring turkeys and chickens were there from morning till evening. They never allowed Aletia to get more than half grown. Even when, the 20th of September, I brought hundreds of Aletia larvæ into one of the fields for experiments with Pyrethrum the turkeys hunted them out, and, with superior interest and eyesight, in a few hours none were left except two, which were old enough to web up before they were found out.

How they should find the Boll-worm so often I do not know, but as a fact it was vain for me to mark stalks with young Heliothis upon them with a view to future observations. The turkeys were there from morning until night, and no *Heliothis* dared to show his head, as they often do at close of day, without danger from these vigilant guards. Practically, I was compelled to cage all I proposed to watch. To the great planting interest these facts can be of little value. It would require flocks of immense numbers, and to be herded about over the fields, to accomplish anything proportionate to what is above related of small patches near habitations. Jays, blackbirds, woodpeckers, and crows destroy vast numbers of Heliothis in corn about the time the grain begins to toughen, but these allies levy toll also on the crop. * * *

Very respectfully,

LAWRENCE JOHNSON.

Prof. C. V. RILEY,
Chief United States Entomological Commission.

THE COTTON WORM.

(*Aletia xylina*, Say.)

Order LEPIDOPTERA; Family NOCTUIDÆ.

Pending the issuance from the printing office of the special report on this insect, which will form Volume IV of the reports of the United States Entomological Commission, it will be well to devote a few pages of this annual report to the subject, in order to meet the constant demand for information. This will best be done by reproducing, 1st, part of an address delivered at the Atlanta exposition, giving a summary of principles we have established and work we have done; 2d, a letter to Hon. E. J. Ellis, M. C., on the best way to meet a possible emergency in the overflowed Mississippi cotton districts; 3d, an illustrated description by Professor Barnard, adapted in advance from the special report on the subject, of what we consider one of the best and simplest spraying machines; 4th, a summary of damage done by the worm in 1881, as furnished by the statistician from replies of the Department correspondents to a special inquiry on the subject; 5th, some recently-ascertained facts in the natural history of the species, and particularly the settlement of the question of hibernation within our borders.

ADDRESS ON THE COTTON WORM.

[From an address delivered by C. V. Riley before the Cotton Convention at Atlanta, November 4, 1881.]

THE COTTON WORM; BRIEF STATEMENT OF PAST WORK.

You all know some things about this insect. Under the various aliases of Cotton Worm, Caterpillar, Army Worm, or old French *Chenille*, it has been a dread to the cotton-grower of the United States since the beginning of the century. A native of Central and South America, its advent in the northern portion of the continent was no doubt coëtaneous with the introduction and cultivation of cotton. Appearing in destructive numbers at irregular intervals, it was looked upon as an unmitigated evil entirely beyond man's control.

The most careful statistics, compiled at my request by Mr. J. R. Dodge, the leading agricultural statistician in the country, show that during the period from 1865 to 1879 the average annual loss to the cotton-growers from this cause was $15,000,000, while in some years it reached nearly double that sum. On the principle of "a penny saved is a penny earned," this is so much stolen from your pockets. Since 1879, notwithstanding increased acreage, the loss has been less, owing to the more general adoption of methods for repressing the worm. It at first seems astonishing that with such large losses to the staple crop no systematic attempt should have been made to overcome this, the planter's worst enemy; that no enthusiastic naturalist should have arisen among you, either before or after the war, to take hold of the problem, and at least summon all the aid that science and intelligence could bring to bear to solve it.

But whatever the explanation, the fact remains that up to 1873 the planter was practically at the mercy of this Aletia, while up to 1878 there existed a vast amount of theory and scarcely any exact knowledge relative to its nature and habits. A few Southern men like the late Thomas Affleck, of Brenham, Tex., and Dr. D. L. Phares, now of the State agricultural college at Starksville, Miss., had written intelligently of what they had observed in their own limited regions, but without laying claim to that general entomological knowledge and experience which was necessary, whether to correct interpretation of the manifestations or the practical solution of the problem. Prof. Townend Glover also did his very best work in this field, but the practical outcome had been the use of fires and lamps to attract and kill the parent moth—methods, at the best, more or less unsatisfactory and ineffectual in preserving the crop.

In 1872 I suggested the use of Paris green to destroy this pest, and in 1873 confidently recommended it for the purpose, in an address which was very generally copied in Southern journals. The planters in the more southern portions of the cotton belt, who, after the war, and while struggling against many adverse influences, had seen their crops ruined year after year, and had become well-nigh discouraged, hailed this remedy with profound joy, and many were the touching expressions of appreciation and thankfulness which I received from various quarters. Men more zealous for their own gain than for the public welfare patented various combinations of Paris green and other arsenical poisons, and did a lucrative business in selling rights to use their various compounds under names that conveyed no idea of their nature. They all had arsenic in some form as base, and feeling that the patentees were, in great measure, imposing on the public, I used my pen and influence to stay the impositions. The period between 1875 and 1878 was one of activity in the improvement of appliances for using the poisons, but they all had for their object the throwing of these last, in liquid or powder, broadcast over the plants.

Although I had long felt that the subject was one of the greatest importance, well deserving the attention of the national government, the opportunity to begin a thorough investigation of it was first offered in 1878, when, as Entomologist to the Department of Agriculture, and with the hearty assistance of Senator Morgan, of Alabama, and other Southern Senators and Representatives, I secured a small apropriation of $5,000 for the purpose. The investigation has not been without obstacles and difficulties. During the first two years the prevalence of yellow fever was an impediment, and as the most interesting sections, from the Cotton Worm standpoint, are the most malarious and unhealthy, and observations must be made during the night as well as by day, few of my agents have escaped sickness after a summer's work in the field. Prof. W. S. Barnard, who is here with me now in charge of the machinery on exhibition beneath this hall, and to whose perseverance and ingenuity we owe various important mechanical contrivances, was so seriously ill at Selma last fall that I once almost despaired of getting him back safe to his home in the North. I mention these facts because the synopsis of results which I shall now endeavor to present to you will convey no adequate idea of the time and labor involved in getting at the truths which, once obtained, appear simple enough. "What is missed is mystery, what is hit is history," and you have all no doubt laughed at the simplicity of some feat or trick of legerdemain after it was once explained, where before you had puzzled your heads in vain for the explanation. Nature's truths are all simple when we have once learned to read them, but the key to unlock them is generally revealed to us only after much patient and intelligent search in field and laboratory,

NATURAL HISTORY OF THE COTTON WORM.

Here [pointing to diagram] you have illustrated a worm which you are all more or less familiar with in its general aspects and its consequences. It belongs to the same order (Lepidoptera) as the Silk-worm. The one industriously spins for us that most lustrous and unequaled fiber that plays such an important part in the commerce of the world, and was for a long time a fit emblem of royalty; while the other is bent on destroying that fiber which, though less rich and costly, is more important to the multitude. The one by study, experience, and experiment man has succeeded in artificially propagating; the other, by the same methods, he may succeed in destroying.

Omne vivum ab ovo. All life comes from an egg. Modern science confirms this Linnæan aphorism. Our Cotton Worm invariably hatches from an egg, and the very common belief among planters that it has a spontaneous origin, or in some way comes from cotton-seed, is childish. The egg is 0.6^{mm} wide, circular, much flattened, and ribbed. Bright, bluish-green in color when first laid, it is attached singly to the under side of the larger and lower leaves, and is easily overlooked. In from two to four days after being laid—the time varying with the season—the young worm hatches. It feeds for a few days upon the under side of the leaves, making yellowish and semi-transparent blotches. These, to the well-posted planter, betoken its presence, where otherwise it would remain unnoticed. It sheds its skin five times and acquires full growth in from one to three weeks after hatching, according to the season. It riddles the cotton-leaf only in the last half of its worm-life and eats more during the last two days than during all the rest of its existence. I want you to bear this fact in mind, as it explains the apparently sudden appearance of the worm, so often remarked upon. When full-grown the creature spins a slight web, usually in a piece of rolled-up leaf, and becomes a chrysalis, which from its nature must always be formed above ground and cannot burrow beneath the surface of the soil. This state lasts on an average about one week in midsummer, but two or three times as long in spring or fall. In due time the moth or imago issues. This moth has a series of wavy, lilac-colored or crimson lines across the somewhat olivaceous front wings, which generally have a clay-yellow or faintly golden cast, but it is chiefly distinguished by a dark, oval spot on the disk of each wing, and by three minute white specks dividing the space between this dark spot and the shoulder in three equal parts. It rests with the wings forming a straight line along the back. It is nocturnal in habit, resting during the day, and taking but a short, startled flight when disturbed. In the early part of the night it is busy feeding and hovering from plant to plant, in flight contrasting strongly with its darting day-flight. In the latter part of the night and small hours of the morning the sexes pair and the female is engaged in ovipositing. Its food is chiefly the saccharine exudations from certain glands on the under side of the midrib of the leaves and at the bases of the outer lobes of the involucre, though it will feed on all sorts of other sweets and is capable of fretting the surface and sucking the juices of fruits.

The time elapsing from one generation to another varies according to temperature, and, therefore, according to season. There is increasing activity and acceleration in development from the first appearance till July, and thenceforth decreasing activity and retardation in development till frost. Thus in midsummer the whole cycle of individual life, from the hatching to procreating, may occupy less than three weeks, while in spring and late autumn it may occupy twice that time. Taking the whole season through, however, the time from the egg of one generation to that of another will average about one month.

The first worms appear much earlier than was formerly supposed, viz., from the middle of April till the middle of May, in the southern portion of the cotton belt. The fact that these early worms generally attract no attention, and that the species seldom acquires disastrous force till the third generation, has given rise to the erroneous notion of later first appearance. There are also many more generations than has been supposed, seven or more being produced toward the Gulf, the last enduring till frost cuts it off. When I tell you that in addition to this rapid succession of broods the moth is one of the most prolific with which I am acquainted, capable, in fact, under favoring circumstances, of laying six or seven hundred eggs, you will no longer wonder at its destructive capacity. The progeny of a single female may, in less than two months, under the influence of midsummer temperature, reach twenty billions, while you all know that half a dozen worms to a plant are sufficient to jeopardize the crop. Why, were it not for the various natural checks upon the increase of the species in geometrical ratio, successful cotton-culture, with all our improved methods for destroying the pest, would be utterly impossible. Remove the barriers and the flood comes. The occasional impotence of the natural checks, through one cause or another, very quickly gives the Cotton Worm the mastery in the struggle for existence, and precipitates it upon us in multitudes almost as if by magic.

I have frequently referred to the southern part of the cotton belt, because the insect acts differently in the southern portion of the belt, where it hibernates, from what it does in the northern portion. Here it appears later and only after having become excessively multiplied further south. The dividing line between these two portions has been approximately given in my Bulletin on the Cotton Worm.

The manufacturers here present have laid stress on the importance of cleansing your cotton from sand, leaf, and other trash before shipment, and Mr. Atkinson emphasized the point in his address yesterday. It may not be generally known that it is the gnawing of the worm which causes the staining and fragments of leaf in the cotton, and that this is much more difficult to remove in ginning than sand or earth, and I wish you particularly to bear in mind that for this reason the destruction of the worm will pay you ten times its cost, even when the worm comes too late to otherwise injure the crop.

Now, I feel that I have got on to a theme of great concern to you all, but I must pass over many questions of interest if I am to reach the chief object of my remarks. To treat of the conditions of soil and plant most favorable to the Cotton Worm, the meteorological influences affecting it, the migrations of the moth, the manner of hibernation, the parasites and other natural enemies, would require many hours' time, and I must pass them by for the present. Before proceeding to the more practical considerations, however, I wish to say a few words, by way of comparison, about another important enemy of the cotton crop, viz., the Boll-worm.

[The professor's remarks were here illustrated by colored diagrams. He gave an interesting account of the Boll-worm, showing its habits and character, and how it differed from the Cotton Worm in transforming underground, in the manner in which the moth rests, and in other particulars, but that the two resembled each other in both feeding at first on the under side of the leaf.]

From the facts here presented it is obvious *that poisons applied to the under surface of the leaves will accomplish far more good than when thrown on the upper surface*, as has been the common custom. They will more surely kill the young worms before these do any damage; they will tend to kill the moths; and they will likewise kill the young Boll-worms. Time will not permit me to go into details as to the different substances that may be used for the destruction of these worms. It suffices to say that of the tons of different ingredients that we have experimented with, Paris green, London purple, or arsenic in some form, give the most satisfaction, while the only vegetable product that gives any promise of usefulness is Pyrethrum, prepared from plants indigenous to parts of Europe and Asia, and the cultivation of which I have been endeavoring to establish in various parts of the South.

IMPROVED APPLIANCES.

"Planters will apply poisons either in liquid or in powder, according to circumstances and conveniences. The wet method, according to present practices, is the more expeditious, and the safer so far as injury to man and stock is concerned. It acts less favorably in wet weather, the first outlay in appliances is greater, and they are often useless where the soil is heavy and wet. The dry method can be most advantageously used in wet weather, and the application is most persistent; the cost of diluents has heretofore been great; there is more danger to the operator, and an acre is poisoned less quickly.

"Experiment shows that in the broadcast methods of sprinkling there is a limit to the subdivision of the liquid beyond which it cannot practically be carried, both on account of the greater tendency of the nozzle to clog and of the greater specific gravity of the poison compared to water in fine spray; so that in attempting to throw fine spray over ten or twelve rows the outer rows receive no poison. This last obstacle applies less to Pyrethrum, which has least specific gravity. In using the poisons dry it does not seem possible to advantageously diminish the amount per acre by any present appliances, but I have reasons to believe that a diluent of simple earth well dried and pulverized may be used with as much advantage as any more costly."*

* Quoted from a paper read in 1880, before the Am. Ass. Adv. Sc.

POISONING FROM BELOW.

Now the throwing of poison from below and the introduction of a new nozzle has enabled us to diminish much further the quantity to be thrown on the plant in either method.

The old-fashioned punctured sprinklers, and perforated or gauzed sifters, with which all are familiar, have proved impracticable, because of the fine holes becoming clogged by wet poison and other materials. To prevent this, stirring, shaking, and straining appliances have been combined with them, but without as good results as we desire.

What may be called slit-nozzles have been made in numerous forms. The fluid, being squirted out through a slit, expands in a fan-like shape, and thus breaks up into a sheet of spray. The fissures have been cut in different angles and curves to produce several kinds of jets, and some can be enlarged or reduced by an adjustable screw. Where large and coarse sprays for broadcast sprinkling are desired, and the opening may hence be coarse, these answer admirably; but for very small, fine sprays, such as are needed in poisoning cotton from beneath, the slit must be so fine as to clog. To remedy this difficulty we have an improvement adapted to all nozzles of this class. The fluid is forced into the round nozzle chamber through a tube or hole tangential to its circumference, thereby causing an intense whirling motion against the inner surface and its slit so as to wash away and keep in action the particles which would otherwise tend to accumulate upon and clog the narrow outlet. The nozzle chamber can be easily opened to remove what collects within.

Lip nozzles are such as spread the liquid into a shower by squirting it against an inclined surface or lip, which may be formed flat to deflect in one plane, or angular so as to throw in two or more planes, or conical to produce funnel-shaped sprays.

Nozzles of this class are excellent for broadcast sprinkling. The lip resists the fluid after it is freed from pressure, thereby retarding it slightly and causing a little to waste by dripping or falling in large drops unless forced with great velocity. An additional pipe to catch and return the drip has been used.

Rotary nozzles are of several kinds. Those in common use, as lawn sprinklers, work on the principles of Barker's mill and of the windmill. The water striking the inclined surfaces of a rotary part makes it whirl so as to throw and break the fluid to pieces. Then there are ordinary tubular hose nozzles with the caliber rifled for all or a part of their length to give a spiral movement whereby the fluid is thrown into a spray.

The rotary nozzles noticed are only available for broadcast sprinkling; but we have one named the cyclone nozzle, which is not only suited for the same purpose by atomizing fluid fine, and in any volume, but which is well adapted for spraying the foliage beneath. The round nozzle chamber has a tangential inlet, and at right angles to this a round central outlet. Fluid forced through it whirls with an incomprehensible velocity in a volute course to the central orifice, producing a broad, fine, beautiful spray. This nozzle is the best yet invented for spraying.

Our machines for throwing poisons are arranged in four natural classes:

1st. Brush throwers.
2d. Rotary fan blowers.
3d. Bellows blowers.
4th. Squirting machines.

I must omit all detailed consideration (though you will find on the grounds many ingenious improvements which we have made in their application) and confine my remarks to the squirting machines which are the most valuable for our purpose. A great many kinds of force pumps have been tried. The rotary seems best suited to combine in machinery, but as yet we have none cheap enough for the planter. Among the piston pumps several are cheap and work well, as Whitman's fountain pump, the Little Giant, Ruhmann's, &c. No improvements of much value have been recently added in the pumps which are suited for our purposes. As a rule the simplest are the best and cheapest.

But the greatest advance in this line is shown in our automatic sprinkler, which entirely does away with the labor of operating pump. A windlass arrangement elevates the barrel of poison so high that gravitation supplies the spraying power. Probably no more simple or practical method than this can ever be invented, and it will remain a standard process.

Fire extinguishers worked by gas pressure have been tried for spraying fields, but those in use are too expensive and waste an unnecessary quantity of chemicals. We have an improved method of spraying plants by gas pressure which is cheap and easily managed.

We have a rotary fan blower in combination with diverging pipes ending in forked lips and mounted on a triangular tripod frame with hind swiveled wheels and front gearing, with belt to move the fans at 2,000 revolutions per minute.

We have rotary fan blowers for throwing fluid poison. We have bellows blowers in combination with a plow or cultivator, whereby the cotton may be poisoned while it is being cultivated. We have, further, compound fountain sprinklers through which the water may be forced by a pump or by gas pressure or by gravitation. In the simplest and best machine we have the water is forced through a system of dichotomously branching tubes, the last fork flexible so as to hug and sprinkle two rows from beneath. The flexibility allows no breakage in pipes, and the trailing flexible forks adapt themselves to crookedness and variations in the width of rows.

The advantages of the triangular, tripod, tricycle frame are that it conforms to all irregularities in all directions. It cannot well tip over; it forms the base of a pyramid supporting the barrel of poison; it turns easily and short as upon a pivot; it pulls easily and it opens and shuts to suit the width of the rows.

With this machine from twelve to twenty rows of cotton are easily and effectually poisoned from below at a minimum cost of machinery, and with the minimum quantity of material.

As a few minutes spent in witnessing the working of this machinery on these grounds will convey a better idea than any amount of further description, I will detain you no longer, but earnestly invite you, upon adjournment, to examine it. With a first outlay of from $10 to $15 for machinery, not more than one cent per acre for material and the labor of one man and a team, one hundred and fifty acres of cotton can be poisoned and protected in a day. What more, gentlemen, can you desire?

No one feature of this marvelous exhibition, which does so much credit to the projectors and managers, has interested me more than the trial ground, where your Southern crops and cotton from all parts of the world are under cultivation for comparison, and I felt an intense mortification when I found upon arrival here that this cotton was all defoliated by the worm. Estimating that the plot contains two acres, it could have been protected in less than an hour, and with less than a dollar's outlay, and it would have been a veritable pleasure to me, and a most telling practical lesson to you, to have seen that interesting patch of cotton now in full leaf, while destruction was all around, and it should have been had I known of its existence in time.

There is one other fact I desire to call your attention to before taking my seat. The work we have been doing on this Cotton Worm is not sectional. The appliances I have described to you, which have been perfected for the benefit of the South, will benefit all sections of our country, for they are applicable to the potato crop and to many other crops. I wish our legislators to bear this in mind, for our work in this field illustrates what has proved true in many other fields, viz., that what benefits any particular section redounds to the common good.

I thank you, gentlemen, in conclusion, for the attention you have given to these fragmentary remarks. I have shown you but the barest outline of the many interesting and important questions raised by the consideration of a single insect. What I have said is simply suggestive of the many things that have necessarily been left unsaid, and my object will have been fulfilled if the remarks lead to questions from the practical planters here congregated, and to profitable discussions. The Cotton Worm is but one of many insects that affect your staple; cotton is but one of many products which form the basis of our prosperity as a people, and which are all more or less affected by insect enemies which call for attention from the Entomological Division of the Department of Agriculture. This Division, again, is but one of several embraced in that Department, which has for aim the amelioration of the farmer's condition and the advancement of the greatest of all industries.

PROTECTION FROM INJURY IN THE REGIONS OVERFLOWED BY THE MISSISSIPPI.

The following letter of recommendations was written in obedience to a request from Hon. E. J. Ellis, M. C., and from Messrs. Shattuck & Hoffman, of New Orleans, for information that could be used in the papers, and otherwise, in order to enable the planters in the regions overflowed by the Mississippi to prepare for possible injury:

DEPARTMENT OF AGRICULTURE, ENTOMOLOGICAL DIVISION,
Washington, D. C., April 25, 1882.

SIRS: The planters of the Mississippi flats, especially those in the flood country, are probably correct in expecting unusual damage from the worm to follow as a consequence upon the crop being belated. It is only a fair supposition from the present outlook that the plant will be seriously attacked before it begins to make a crop. On these accounts the relation of most of the planters of that extensive region as mortgagers to the great mercantile houses that advance their supplies on the ruinous credit system there prevalent, is at this date very unpromising and unsatisfactory to both parties. And these premises naturally account for the unusual number of letters now coming from planters and merchants of that section of our country inquiring for information respecting the pest and the best method of preventing or resisting its progress.

It would indeed seem wise for those who advance supplies upon security on the prospective crop to furnish also the appliances for destroying the pest, and insist on these being purchased, and perhaps with an agreement to use them faithfully for

PROTECTING THE CROP,

as a prerequisite to obtaining such heavy credits as so many have become accustomed or forced to ask and expect. Such investment should be a kind of insurance or a sort of security somewhat equivalent thereto.

The old-fashioned watering-pots are sold in quantities in some instances, but by these the poisoning is done in a poor, primitive manner, which is always unsatisfactory and often quite unsuccessful. None of the barrel-pumps, producing broadcast sprays, have become such standard machines that the trade could have confidence to invest in quantities of them or feel sure of disposing of a large invoice. Many of these have considerable local notoriety and sale, and some hydronettes of northern manufacture have found a more general distribution, but it cannot be said that any one of these has become such a standard machine as large jobbers would dare to handle. Indeed there seems to have prevailed the sense that the special requirements for the thorough and wholesale destruction of the worms were not yet met by the machines made, and the suitable article has long been looked for and hoped for in vain.

During the investigation which I have been conducting, practical machines on new principles have been invented and tested that satisfy all the conditions of this difficult problem to destroy the worm in an economic, certain and wholesale manner. *The idea of first importance is, that the poison be applied to the under surface of the foliage*, where the young worms start and grow until large enough to eat through the leaf and become destructive, where the poison will remain on and not be washed off by dew or each shower of rain.

To devise the mechanical means of accomplishing this on a large scale, or in a rapid manner, was the more baffling under the conditions that complexity and much expense must be avoided. But all the more difficult points have been overcome by contrivances which are beautifully simple and practical, and it is to be regretted that they probably cannot be put on the market before next season; hence it would not be worth while, did space permit it in a letter like this, to enter upon a detailed description of the improved machinery referred to, which will appear in a final report soon to be printed. For the present, then, only the older machines are available, and I have sent to Messrs. Shattuck & Hoffman, of New Orleans, such copies as the Department has to spare of a report in which their descriptions and relative merits are presented, only directing your attention specially to the broadcast spray pumps made by Mr. R. T. Deakin, Philadelphia, Pa.; Mr. J. P. Ruhmann, Schulenburg, Tex.; and Mr. John Schier, Ellinger, Tex.

The only desirable poisons that will be obtainable in great quantites by the planters are the various arsenical preparations, and foremost among these are

PARIS GREEN AND LONDON PURPLE.

By the ordinary method of *sprinkling poison* from water-pots, or in broadcast sprays from barrel pumps, about 40 gallons of water containing one pound of Paris green or two-fifths of a pound of London purple, kept well mixed by stirring or shaking, may be applied to the acre. When a bellows atomizer is used to diffuse it more finely and more thoroughly, which is much preferable, less than half that quantity of poison and water to the acre will give equally good results. In *sifting on dry poison* by such sifters as are usually employed, one pound of the Paris green to 35 pounds of such mixture of flour and ashes, or one pound of London purple to 45 pounds of such mixture, are proper proportions to use. The flour is adhesive, holding the poison fast to the leaves and coating the particles of poison so that they come less in contact with the surface of the plant, and hence it helps to prevent their caustic action or burning of the leaves. The ashes have a still greater ameliorative effect in preventing the caustic action, and on this account it is well to use as much as one-third ashes to two-thirds flour to form the mixture. With this preparation the poison cannot be too thoroughly mixed. Better devices for mingling these homogeneously with each other are still to be sought. The best now easily prepared by the planter consists of a barrel with a number of rods put through it endwise and a great number of large spikes driven through its sides to project far into the cavity.

THE SUBSTANCES TO BE MIXED

are put into the barrel through a large hole, which is then closed, while the barrel is hung upon an axis and rotated until thoroughly mixed.

It should be added that in case the poisons recommended are in any instance not obtainable, the pure *arsenic* or *arseniate of soda* may be resorted to, since these have been used to advantage, though not always with the best satisfaction. Although these substances are cheap, their caustic effect on the plant is greater. The mixture now most used consists of 20 grains of arseniate of soda and 200 grains of dextrine, dissolved in one gallon of cold water. Four ounces of this mixture to 40 gallons of water can be sprinkled on each acre. The common arsenic water, which every druggist knows how to make, will answer well. To make it from the white arsenic (arsenious acid) and common baking (carbonate of) soda is cheaper than to buy the arseniate, although the arseniate method of preparation involves less time and labor. One-fifth of a pound of sal soda to a pound of arsenic should be boiled in a gallon of water until dissolved. The solution is permanent, no stirring or shaking being necessary to keep the poison mixed. One quart of the solution to 40 gallons of water is used on each acre.

In applying poison with blowers, a much smaller quantity of the poison and its diluents will be sufficient, and when the poison is blown onto the under surfaces the adhesive element is no longer needed.

Both Paris green and London purple, when not adulterated and where properly applied have always given satisfactory results. The latter seems to act a little slower than the Paris green; perhaps because the worms do not eat it so quickly, for they refuse to eat poisons until they become very hungry, but it is much the cheapest, and being a finer powder is susceptible of a much thinner distribution than it usually gets. If very thinly and evenly applied it will be eaten sooner, and when used in due time will prove equally as effective as the Paris green. And it is likewise commendable to administer any poison whatever that is to be used so early as to destroy the worms before they reach destructive size, and before they appear on the upper surfaces of the leaves. Planters must be urged to watch carefully the under surfaces of the foliage throughout the cultivating season. The very young worms are less easily seen than the small spots of light color made by their gnawing off little patches from the lower surfaces of the leaves. As soon as and whenever the young ones have started, apply the poison immediately beneath the foliage. The plowman or "weed-chopper" should be taught how to see the young worms and be carefully trained to find them. At the same time he should have hanging from his shoulder or plow a light bellows atomizer charged with poison ready for use.

It must always be remembered that THE WORMS ARE AT WORK NOW on certain plants in certain fields from March until winter; that the killing of one early insect may prevent thousands of future progeny and save hundreds of dollars. In the wet country the early worm will probably be found first on the earlier cotton on the dryer, sandy ridges, or higher clay slopes; while the later worms, which have generally been the first ones noticed, and only observed when they appear in very destructive numbers, may, to the less careful observer, first come to view in either the same kinds of "cuts" or in the wet buckshot lands, upon which they thrive especially well in the latter part of the season.

A fuller history of the insect's life would help the planter better to understand its habits, but these details cannot be briefly enough presented to be further described in this letter.

POISONING DEVICES.

As already stated (p. 153), only one example can be selected from the special report on the Cotton Worm for preliminary presentation here, and we will describe the apparatus represented in Plate IX, Figs. 1–3. Several other combinations and adaptations of the parts to be noticed will appear in the other report.

MACHINE FOR SPRAYING FROM BELOW.—This machine is transported by combination with a wagon or cart or other suitable vehicle, and consists of a skid, bearing a barrel or other poison receptacle, the force pump and stirrer operated therein, the hose-pipe leading from the pump-spout and communicating with the several branched pipes which terminate in nozzles carried or trailed beneath the plants to deliver the poison spray upward onto the under surfaces of the foliage.

The skid is a simple frame to hold the horizontal barrel from rolling, and consists of two pieces, Fig. 1, *a a*, of wood, about the length of the barrel, and in section about 3 by 4 inches, joined parallel apart from each other by two cleats, *b b*. The inner, upper angles may be cut to match the curve of the barrel, as at *c c*. The barrel being placed upon this frame is next to be filled.

A good device for mixing the poison thoroughly with the water and for filling the barrel is shown in section in Fig. 2. It consists of a large funnel that will hold a bucketful, and has cylindrical sides, *g g*, that rest conformant on the barrel. In this is a gauze or finely-perforated diaphragm, or septum, *d*, and a funnel-shaped base, *j j*, with its spout, *p*, inserted through the bung. The London purple or other powder is to be put in the funnel and to be washed through the fine perforations by the water which is poured or pumped in through it into the barrel, *k*. Thus no lumps of poison can enter, and the grains of poison being thoroughly wet and separated remain better suspended in the reservoir. Where flour or other adhesive material or diluent of the powder is to be used such ingredients should be washed in first and the poison afterwards.

By reference to Fig. 2 the barrel, *k*, will be seen in section, and some of its details, together with those of the pump and stirrer, may be noticed. The fulcrum, *f*, has a foot below screwed to the barrel. Through its top is a pivot, *o*, on which tilts the pump-lever, *l*, which is similarly hinged, at *b*, to the top of the piston-rod, *t*. The pump cylinder, *g*, is also hung upon trunnions, *i*, projecting into eyes. In this illustration the eyes, *e e*, have each a neck fitting in a slot cut through the stave oppositely from the side of the bung-hole, and beneath the stave is a foot on the eye-piece. Its neck is so short that the eye is held down firmly against the top of the stave, while the foot is as tight against its under surface. The length of the eye-piece is a little less than the diameter of the bung-hole, into which it may be inserted to be driven laterally into the slot. The slot is longer than the eye-piece, so the latter may be driven away from the bung-hole for a distance greater than the length of the trunnion-pivot. Then the pump being inserted, until these pivots come opposite the eyes, the latter may be driven back as sockets over the pivots which play in them when the pump is worked. To hold these eyes toward the pump and upon the trunnions a wedge, *v*, is driven in the slot beyond each eye-piece. Thus the pump is easily attached or removed and its union with the barrel is strong and firm. Perchance it be desired that this pump-hole be bunged the side slots may be wedged to make the barrel tight.

The parts of the pump being hung as described, the hinge, *b*, forms a toggle-joint, and in its action causes the pump to oscillate on its trunnions, its basal end swinging wider than its top, as indicated by the dotted line from *x* to *y*. Upon the extremity of this swinging end is a loop, *h*, through which is passed a stirrer-bar, *m n*, made to sweep back and forth in the lower side of the barrel thus to agitate and mix the substances considerably during the operation of the pump, every stroke of the handle causing one or two strokes of the stirrer.

The method of inserting and extricating the stirrer-bar is as follows: It is raised with the pump until the end, *m*, comes opposite the bung-hole, *x*, through which the bar may be pulled out by the cord, *w*, which is attached to the end, *n*, and also preferably to the bungs, *r* and *z*, as shown. Through the same hole the bar may be inserted. This stirring device is the simplest in construction and operation of any yet contrived, while working as it does with reference to the concavity of the barrel it is perfectly effective.

Pumps having other external or internal constructions than those shown here may be similarly mounted, and it matters little if the eye or the trunnion be either on the pump or on the slot-piece. But some of the points in the internal construction of the pump may be briefly noticed here. The lower extremity of the piston-tube is closed and has a circular seat above which is a slot-shaped entrance to the cavity of the piston-tube. Higher, is another circular seat, and immediately above it another inlet to the piston-tube. Between the two seats is an circular slide-valve, which bears a packing on its face and plays loose or free up and down as caused by the pressure to open the lower inlet during the downward stroke and to close it on the upward stroke. The upper cap of the cylinder is quite loose about the piston-pipe, and holds one end of a sheath or tubular packing, the lower free end of which fits snugly around the piston-pipe and tighter to the same when the fluid-pressure is on the outside of it. The piston-tube has about half the capacity of the outer cylinder, and the whole arrangement is such that the pump discharges during both strokes, being a constant-acting or double-acting force pump, which operates the same whether the discharge be taken from a spout, upon the side of the cylinder or from the side or end of the piston-tube. With the discharge from the piston end, and a suction-hose upon its opposite extremity, the pump may be used apart from the barrel, like the so-called "fountain pumps" and "hydronettes" of the trade. Its valves are all metallic, and it may be made for the highest pressures or to throw any volume desired. A one-half inch discharge-spout delivers volume enough for an eight-row machine like the one before us.

From the spout a main pipe or hose communicates to a pipe extending across and above the rows and bearing branches descending in the alternate interspaces between the rows, while each is provided with a fork or pair of arms to supply a pair of rows. In this special form of the machine the main cross-pipe is hinged to the two sides of the body of the wagon, and at one of these junctures is a lever with a ratchet quadrant whereby to elevate the descending pipes with the arms and nozzles when turning, or to surmount stumps or other obstacles, for in this case the descending pipes are inflexible and stiffly attached to the main cross-pipe and the lever, that they may be elevated by depressing the latter, which can be set at any notch desired, so that the arms may be allowed to trail or drag, or may be suspended partly or wholly near the ground or higher to suit the operator.

There are other ways of attaching this apparatus which allow it to conform to the irregularities of the ground more thoroughly and independent of the rocking of the vehicle, but it is unnecessary to describe them in this connection.

The two arms of the main cross-pipe extend in a direct line and have all the joints and segments stiff, while the segments have each a length equal to the width of a pair of row spaces, whereas by another construction set forth in the large report, the main arms are either partially or wholly flexile in their joints or segments, or both, and they may stand at an angle with each other, or continuously parallel, as desired. In those cases the parts are supported by a bar or frame which may or may not have runners or legged-wheels other than those of another vehicle combined therewith, and the descending branches are also usually made partially or wholly flexile, that they may trail or drag more thoroughly, conformant to the irregularities of the ground and the rows. Similarly the terminal branches on the descending tubes may stand parallel or at an angle with each other and be straight or curved, with or without flexile joints or segments, but the exact construction in the present example is illustrated in Fig. 3. While some curve seems usually desirable, it may be made either in the descending branch or its fork, or in the terminal arms, or in all these parts.

Referring to Fig. 3, *t* is the descending pipe, *y* its fork, which may be braced by an additional piece, and this may serve as a weight to hold the fork from being lifted or tilted, or as a slide plate, beneath, to prevent the ground from wearing the parts above it, or a separate slide-plate or independent weight, freely removable or not, is sometimes combined with the fork, as will be shown in the other report referred to. There are also different ways of making the angle-piece, and one of the best is where two curved pieces of tube are cut and matched together so as to form a 3-way fork, the angle, *y*, between the horizontal parts being about 90°, and the elevation of the part, *t*, which is inserted in the descending branch, is about 45° from the horizontal base-plane. Such a fork offers the least possible resistance to the fluid forced through it. In the figure the tubular arms, *i i*, are joined to the angle piece by the flexile sheath couplings, *e e*, having stout wraps. To prevent the joint thus formed from being too flexile, and to give it additional elasticity, a rod of spring metal extends inside. These spring rods cause the arms to spring to the bases of the cotton plants and the fork to open or close as pressed upon by the row or not, and thereby conform the positions of their terminal nozzles, *n n*, to the variable width or courses of the rows, to apply the same to discharge from about the basal center of each plant upward into its foliage.

The nozzles may be joined inflexibly or by an elastic union with sheath and spring rod, or in any of the flexile parts named spring-lined suction hose or a torsion spring to allow partial but not complete rotary movement may be employed. Each terminal arm forms a supply tube to its nozzle chamber, which has an eccentric inlet-passage, from the same tangentially through its wall, admitting the fluid so excentrically that it whirls in the chamber and discharges through a side outlet in the form of a spray. The whirl thus produced is very intense and gives the fluid such centrifugal motion as will disperse it broadly from the orifice and thus produce a very finely atomized spray. The spraying power varies with certain details in the proportions and construction of the passages and other parts. With a suitable straining device in the base of the pump, bodies large enough to clog the small outlet cannot enter, but, should clogging materials enter otherwise to interfere with the discharge, the face and back of the chamber may be easily taken apart to remove matters from the interior. The nozzles project so little beyond the supply-pipe as hardly to catch upon the plants, and in case any objection be raised to the slight recess sometimes occurring between the chamber and its pipe, that may be filled completely by metal. This same nozzle is used with equally good effect on other pipes, hydronettes, syringes, or pumps, as well as on blast atomizers, and is unsurpassed for spraying from the ground upward, as here desired.

The whole contrivance as an eight-row machine is light, can be hauled rapidly, and has been tested sufficiently to show that it is practical By adding two additional arms twelve rows may be covered.

DAMAGE IN 1881.

ALABAMA.—*Talladega:* Appeared late and only on luxuriant growth in some sections. *Limestone:* Shed more from want of proper cultivation and rain and drought. *Lawrence:* In low bottom-lands to some extent. *Conecuh:* All the top crop destroyed. *Barbour:* Partially in many fields rust preceded the caterpillars and destroyed what they would. *Perry:* Prairie early and sandy land later. *Chilton:* About three-fourths stripped of leaves early; after rain budded out but made nothing. *De Kalb:* Stripped in some sections. *Saint Clair:*

Some fields were not touched while others were entirely stripped. *Cherokee:* Some fields stripped early, others not at all. *Russell:* On bottom-lands early. *Marengo:* Stripped entirely where no poison was used.

ARKANSAS.—*Hempstead:* Some spots none; others as high as 50 per cent. *Pulaski:* Earlier than ever before. *Woodruff:* Only the foliage and unmatured bolls. *Jackson:* By the Army Worm. *Montgomery:* Many fields stripped after the cotton had matured. *Pope:* Later than usual. *Howard:* Leaf Worm came early but did no damage. *Monroe:* Whole region stripped bare of foliage.

GEORGIA.—*Bibb:* On bottom and new land only. *Muscogee:* On low-lands early; uplands later. *Lowndes:* Second crop of foliage entirely stripped. *Hancock:* Entirely on low, wet lands. *Jones:* Stripped entirely on red lands; gray land suffered but little. *Dooly:* Only partially. *Morgan:* In consequence of the very late fall and frost. *Lincoln:* Few fields. *Liberty:* Partially. *Early:* Some localities early. *Oconee:* Picking of the best cotton was done before the worms came.

FLORIDA.—*Columbus:* Many fields stripped. *Madison:* Only in portions of the county. *Sumter:* Was stripped entirely.

TENNESSEE.—*Bedford:* Boll-worms are unknown here, though catterpillars stripped the leaves. *Lincoln:* Stripped of leaves. *Dickson:* Very little damage done in this county. *White:* Boll-worms do the most damage.

SOUTH CAROLINA.—*Oconee:* Only partially in limited localities. *Greenville:* Crop made before worms came. *Newberry:* In some localities, but so late in season as not to injure yield; rather benefit it by exposing the unopened bolls to sun. *Abbeville:* Where it appeared did not more than eat the leaves on the plant. *Barnsville:* Stripped clean of leaves and young bolls, which came too late to make anything.

NORTH CAROLINA.—Came too late to do any damage. *Lenoir:* Did not appear only in a few places. *Columbus:* Only appeared in a few places and too late to do any damage. *Cabarrus:* Did not appear till after crop was picked; they then stripped the plant. *Wilson:* A few appeared just before frost, but did no damage. *Cumberland:* Few fields had the leaves eaten off, but too late to do any damage. *Pitt:* Few places they appeared, but too late to do any damage. *Cleveland:* Very little.

LOUISIANA.—*Union:* A few places had then reported, but no damage done. *Jackson:* Stripped, but after maturity. *Lincoln:* In some places, but not until after it was picked. *Franklin:* Not until picking was over, then only partially. *East Carroll:* Stripped, except very high land or shaded.

MISSISSIPPI.—*Union:* In some localities, but after cotton matured. *Tate:* Second growth eaten by them (leaves), bolls not hurt. *Chickasaw:* Army Worm destroyed top crop. *Alcorn:* In a few localities, but after the crop had mostly opened. *Prentiss:* Did not appear until about frost, and did no harm. *Rankin:* Very little, and after bolls were matured. *Jefferson:* Destroyed all top crop. *Clay:* Bottom crop at maturing. *Issaquena:* Only partially, and that late. *Clarke:* Owing to the early drought the leaves became so hard and dry that they made very slow progress.

TEXAS.—*Gonzales:* In some places early; others late. *Bee:* Damage at first of season by Grass-worm. *Colorado:* In some sections where not poisoned. *Denton:* Partially by the Web-worm. *Lee:* Where poison was not used the plant was generally stripped. *Houston:* In very few sections, and very late. *Wise:* Came, but too late to do harm. *Brazos:* Very late; too late to injure. *Live Oak:* In some localities. *Wood:* Too late to damage. *Lampasas:* Came too late to damage. *Milam:* Second crop damaged in some localities. *Van Zandt:* Caterpillars came early and made clean sweep. *Grimes:* Only top crop injured, which seldom amounts to anything. *Palo Pinto:* Stripped but very little. *Leon:* In some places, but too late to do damage. *Fannin:* Some fields were stripped, but not until it was all opened.

Loss of cotton by worms as reported.

States.	No. counties reported.	Loss.	Total, per census.	Loss.
		Bales.	*Bales.*	*Pr. cent.*
Alabama	46	51, 849	509, 616	10. 1
Arkansas	45	15, 055	407, 342	3. 7
Florida	16	4, 077	29, 623	13. 8
Georgia	93	20, 958	582, 332	3. 6
Louisiana	29	29, 649	273, 356	10. 8
Mississippi	39	38, 111	583, 763	6. 5
Missouri	6	....	16, 135	....
North Carolina	56	204	346, 931	....
South Carolina	25	10, 233	418, 943	2. 5
Tennessee	28	1, 374	146, 150	0. 9
Texas	88	22, 472	561, 778	4
Virginia	4	....	7, 800	....
Total	......	193, 483	3, 880, 769	5 4. 9+

Total cotton produced, 6,589,000 bales; total cotton produced in counties reporting worm, 3, 880, 796 bales, or 57.4 of the whole crop.

POSSIBLE FOOD-PLANTS OF THE COTTON WORM.*

One of the most interesting characteristics of the Cotton Worm is that it is so strictly confined to Cotton as its food-plant. All attempts hitherto made to discover additional food-plants have proved futile; nor have we been able to ever make it feed successfully on other plants allied to Gossypium.† We have, however, long felt that there must be some other wild plant or plants upon which the species can exist, and this belief has been all the stronger since it was demonstrated two years ago from observations made by Dr. P. R. Hoy that the larva may occur in Wisconsin, and, consequently, out of the range of the cotton belt.‡ We have given special directions to those in any way connected with the Cotton Worm investigation to search for such additional food-plants, but so far no additional food-plant has been discovered. Last November we received from Dr. J. C. Neal, of Archer, Fla., specimens of a plant with eggs and newly-hatched larvæ which he believed to be those of Aletia, but which belong to an allied species—the *Anomis erosa* Guen. The plant proved to be one of the Malvaceæ (*Urena lobata* Linn.), which is reported as quite common in that part of Florida and further south, being a tall, branching, and straggling weed with annual stems and perennial root, from which new shoots arise in January. It blooms from February to December, and is a valuable fiber plant, the bark of both stem and root being very strong, and used very generally for whip and cording purposes. The leaves have three very conspicuous

* Communicated by the author to the *American Naturalist* April, 1882, pp. 327–8.

† The only partial success in this line is that mentioned in our Bulletin on the Cotton Worm, p. 12.

‡ See Report on Cotton Insects, Department of Agriculture, 1879, p. 89.

saccharine glands on the principal veins toward the leaf-stem, and the plant, Dr. Neal reports, is much less sensitive to cold or frost than Gossypium. We find that the plant has been received by Dr. Vasey, botanist of the Department of Agriculture, from several parties in Florida, with inquiries as to the value of the fiber. *Urena lobata* was, until very recently, not known to occur in the United States. It is common on dry hill pastures almost everywhere in the West Indies and southward to Guiana and Brazil, and is also reported from Western Africa, East Indies, China, and some of the Pacific islands. It seems to thrive very well in Florida, and is likely to spread to other adjacent States.

The *Anomis erosa*, the eggs and young larvæ of which were not uncommon on the leaves of the Urena, may be distinguished from Aletia by the paler, more translucent character of both egg and larva, and by the first pair of prolegs being quite obsolete, in which character it resembles the *Anomis exacta* that affects cotton in Texas. Aletia larvæ that had been fed on cotton, when placed upon the Urena, refused to feed upon it, and finally perished.

We recently took occasion to carefully examine the Malvaceous plants in the herbarium of the Department of Agriculture with some quite interesting results, although a herbarium is naturally the least favorable place one can choose for an entomological investigation of this character, as plants that are least injured by insects are most apt to be collected, and the mode of preserving the plants still further reduces the chances of finding traces of Aletia, because only one side of the leaf is available for examination. How small this chance is may be illustrated by the fact that on the specimens of Gossypium in the herbarium no Aletia eggs or egg-shells could be discovered, and that only one specimen showed any trace of being injured by any insect whatever. Nevertheless a number of eggs or fragments of such—some of them from their structure very closely related to Aletia—were found on the following plants: *Malvastrum spicatum*, from Florida and Nicaragua; *Urena ribesia* (which is considered a form of *U. lobata*), from Southern Florida; *Pavonia typhaleoides*, from Cuba; *Sida glomerata*, from Cuba.

One object of this examination was to discover, if possible, the particular Malvaceous plant upon which Aletia feeds in the States north of the cotton belt, but this proved to be an almost complete failure, because the herbarium contained only six specimens of such plants from the more northern States, not counting sixteen specimens cultivated in the agricultural grounds at Washington. However, on a specimen of *Sida spinosa*, from York County, Pennsylvania, an egg was found which has every appearance of that of Aletia.

We would earnestly call upon entomologists who may read these pages to aid us in obtaining evidence of the food-plant of the insect in the more northern States by an examination of the plants indicated by an asterisk in the following list, as it is upon such that the insect will probably be found at some future time, but only late in the season:

LOCALITIES FOR MALVACEOUS PLANTS FROM GRAY'S FLORA.

Althæa officinalis L.—Salt marshes coast of New England and New York. (Nat. from Eu.)

Malva rotundifolia L.—Waysides and cultivated grounds, common. (Nat. from Eu.)

sylvestris L.—Waysides. (Adv. from Eu.)

moschata L.—Has escaped from gardens to waysides. (Adv. from Eu.)

alcea L.—Has escaped from gardens in Chester County, Pennsylvania. (Adv. from Eu.)

Callirrhoë triangulata Gray.—Dry prairies, Wisconsin, Illinois, and southward.
alcæoides Gray.—Barren oak lands, Southern Kentucky and Tennessee.
Napæa dioica L.—Limestone valleys, Pennsylvania and southward to the Valley of Virginia, west to Ohio and Illinois, rare.
**Malvastrum angustum* Gray.—Rock Island in the Mississippi, Illinois.
**coccineum* Gray.—Abounds on the plains from Iowa and Minnesota westward.
**Sida napæa* Cav.—Rocky river banks, Pennsylvania; York County, Kanawha County, Virginia. (Cultivated in old gardens.)
elliottii T. & G.—Sandy soil, Southern Virginia and southward.
**spinosa* L.—Waste places, common southward.
Abutilon avicennæ Gærtn.—Waste places, escaped from gardens. (Adv. from India.)
Modiola multifida Mœnch.—Low grounds, Virginia and southward.
Kosteletzkya virginica Presl.—Marshes on the coast, New York to Virginia and southward.
Hibiscus moscheutos L.—Brackish marshes along the coast, sometimes extending up rivers far beyond the influence of salt water (as above Harrisburg, Pa.), also Onondaga Lake, N. Y., and westward, usually within the influences of salt springs.
grandiflorus Michx.—Illinois and southward.
militaris Cav.—River banks Pennsylvania, to Illinois and southward.
trionum L.—Escaped from gardens or grounds. (Adv. from Eu.)
syriacus L.—Escaped from gardens or grounds. (Adv. from Eu.)

Of these twenty-two species, eight of which are introduced, at least eleven are not likely to occur in Wisconsin, so that the number of plants upon which the insect will probably be found is very limited, if, as is most probable, the plant really is one of the Malvaceæ.

THE QUESTION OF HIBERNATION SETTLED.

In presenting some of the more recent discoveries of importance anent this insect to the National Academy of Sciences, at its annual session in this city last May, we considered the question of hibernation in the following words:

But my chief object in referring to this insect is to convey the information to the Academy, which, though perhaps of less practical import, is nevertheless of scientific interest. In the remarks which I made in 1879 it was shown that there were various theories held by competent men—both entomologists and planters—as to the hibernation of this Aletia; some believing that it hibernated in the chrysalis state, some that it survived in the moth state, while still others contended that it did not hibernate at all in the United States. There were many known facts which gave weight to this last hypothesis which was espoused by Prof. A. R. Grote. The strongest points in its favor were that the insect had not before been seen in any state during the months of March, April, and May, together with the tendency of error from mistaking other species on the part of those who reported having found either the chrysalis or the moth during the winter months.

Yet there were many facts which, as I then stated, led me to believe that the theory was erroneous, and that, as I have always contended, the insect did hibernate in the southern portions of the cotton belt. How difficult it has been to get absolute and experimental proof of the correctness of this belief may be gathered from the fact that I have had competent agents each winter since that of 1878-'79 fully instructed to search for and obtain such evidence, and that until the present winter it has never been forthcoming. I am glad to be able to state, however, that hibernation is now an established fact upon indisputable evidence, and that during a recent trip to South Georgia and Florida I was able to completely bridge the gap which had hitherto been supposed to exist in the annual cycle of the insect's history.

We have, during the past winter, been able to obtain the moths during every month, and have watched them in fact until the early part of March. We have found the eggs deposited, also, in the early part of March, just as the hibernating moths were disappearing, and I found the worms of all sizes on rattoon cotton during the latter part of that month. I received chrysalides from this first brood of worms two weeks ago, or in the first days of April, and the fresh moths are now issuing. This is fully six weeks to two months earlier than the first worms were discovered in the spring of 1879 and 1880, though we then discovered them in the latter part of April, or several weeks earlier than they had previously been recorded.

In short, there is nothing more fully established now than that the moth hibernates principally under the shelter of rank wire-grass in the more heavily-timbered portions of the South, and that these moths begin laying on the rattoon cotton when this is only one inch or so high. That the first few generations of worms are rarely noticed and never particularly injurious is due to the fact that they are more generally dispersed (the moth appearing to fly great distances, laying here an egg and there an egg, instead of laying hundreds on the same plant, as it does later in the season), few in numbers, and quite liable to the attacks of their various enemies just issuing from their winter quarters and finding a scarcity of other food; also to the less rapid development during the cooler spring months.

Aside from the satisfaction of bridging over so important a gap in the natural history of this destructive insect, the fact established has this important economic bearing: Whereas, upon the theory of annual invasion from some exotic country, there was no incentive to winter or spring work looking to the destruction of the moths, there is now every incentive to such action as will destroy it either by attracting it during mild winter weather by sweets or by burning the grasses in which it shelters. It should also be a warning to cotton-growers to abandon the slovenly method of cultivation which leaves the old cotton-stalks standing either until the next crop is planted or long after that event; for many planters have the habit of planting the seed in a furrow between the old rows of stalks. The most careful recent researches all tend to confirm the belief that Gossypium is the only plant upon which the worm feeds in the Southern States, so that in the light of the facts which I have presented to you there is all the greater incentive to that mode of culture which will prevent the growth of rattoon cotton, since it is very questionable whether the moth would survive long enough to perpetuate itself upon newly-sown cotton except for the intervention of the rattoon cotton.

MISCELLANEOUS INSECTS.

THE URENA ANOMIS.

(*Anomis erosa* Hüb.)

Order LEPIDOPTERA; family NOCTUIDÆ.

[Plate VIII, Fig 1.]

HABITS AND NATURAL HISTORY; RESEMBLANCE TO THE COTTON WORM.

Of the numerous insects, the history of which we have traced in the last few years, one species of considerable interest may here be recorded; for it is not only interesting on account of its occurrence upon a fiber-producing plant, which some day may prove of considerable importance, but also on account of its relations to the Cotton Worm (*Aletia xylina*) for which it might easily be mistaken in its earliest stages.

The species under consideration appears to be quite generally distributed over most of the Gulf States wherever its food-plant (*Urena lobata*), and possibly other nearly related plants, are found growing.

The belief that the eggs of the species now under consideration were those of Aletia was strengthened in the minds of those who first found them by the inference that after the disappearance of cotton, Aletia would have to search for other suitable plants to sustain its offspring until new cotton should commence to grow the following spring; but so far neither its eggs nor its larvæ have ever been discovered upon any other plant but cotton.

The eggs of this Anomis, which so far have been found only on the leaves of Urena, appear, if examined with a common hand-lens, to be structurally indistinguishable from those of Aletia, and were sent to the Department from Florida by Dr. Neal, with the assurance that they really belonged to that insect, and that its winter food-plant was discovered. An examination under the microscope, however, showed considerable differences, notwithstanding the great similarity in size and sculpture. The color is, however, paler, and not of the peculiar bright-green characteristic of Aletia, and it is by this character that the egg of the Anomis may be distinguished from the other, when fresh, by the ordinary observer.

The radial ridges are more numerous, ranging between 35 and 40, and the transverse ribs from 12 to 14. The radiating ribs of the Aletia egg are considerably rounded, with the spaces between them rather narrow, appearing like deeply-impressed striæ, while the ribs of the Anomis egg are sharp and triangular if viewed from above, with the spaces between them shallower and broader. The intersection of the transverse with the radial ribs of Aletia are not sharp, and are only marked by low, rounded elevations. Another quite marked feature of the eggs of Aletia is the arrangement of the radial ribs in five groups, connected with each other by an elevated ridge which forms around the center a large pentangular cell, into each angle of which one of the radial ribs terminates, the other ribs between them being somewhat shorter and connected by the terminal transverse rib. This arrangement is quite noticeable in fresh eggs, but still more in dry ones. The radial ribs in this Anomis, however, are not arranged in separate groups, and the longest ones surround the center in a perfect circle without terminating in a circumcentral rib.

This Urena Anomis is exclusively a Southern species, and it continues breeding with scarcely any intermission throughout the whole year. Moths have been captured in various parts of the South from August, throughout the winter, till May, and the eggs and larvæ of different sizes are found in Florida throughout the winter.

The general habits of the larvæ are quite similar to those of Aletia, though as a rule the Anomis larvæ are less active, especially after they have attained one-half their growth. The newly-hatched larvæ are almost indistinguishable from those of Aletia, both being of the same size and of the same pale color. The former may, however, be at once recognized by the first and second pairs of prolegs being entirely obsolete, whereas, notwithstanding their minute size, the second pair is always present in Aletia. In this stage the larvae are most active and nervous, and are usually found feeding on the lower side of the leaves, which they resemble so much in color that it is difficult to detect them when at rest.

They stretch to their fullest length when resting, but very often may be seen in a position similar to that of the larvæ of Geometrids, and will then, if disturbed, leap from their hold and hang suspended by a thread, which, after a short rest, they will climb with great rapidity. The mode of climbing is very interesting. The head is suddenly bent downward, first to one side and then to the other, and each time the thread is grasped with the thoracic legs when the head is lowest. Growing larger, they become more and more sluggish, and can seldom be induced to spin, but usually hold to the leaf very tenaciously, so that some force is needed to remove them. If disturbed they will try to escape in a looping gait which is similar to that of Aletia. The full-grown larvæ usually assume a very peculiar position when at rest. The body is bent at about the middle in such a way that both halves lie close to each other so as to form a long and narrow loop, and the larva remains in this position sometimes for hours.

The principal time of feeding, as observed in the vivarium, appears to be at night, and the larva usually rests during the day on the lower side of the leaves. The smaller larvæ eat only the softer parts, leaving the ribs untouched, but the older ones gnaw large irregular portions from the edge of the leaves, and will often consume two-thirds of a leaf in a single night. They also have the habit of devouring their own cast skins, sometimes not even leaving the head, and the newly-hatched worms will frequently feed upon the empty egg-shells before attacking the leaf. We have in one instance, however, observed a young larva which had only partly issued from the egg already at work gnawing the leaf.

In March last we still found the larvæ of all sizes on the Urena around Crescent City, Fla., but failed to find any trace of them on any other plant. This has also been the experience of Messrs. Neal and Hubbard, who were instructed to make observations on this point.

The moth was first figured by Hübner (Zutr., 287, 288), and is fully described under the name of *Cosmophila erosa*,* by Guenée, who describes the larva in a few words and gives its food plant as *Hibiscus*. It occurs in South America, the specimens from Brazil being darker and brighter than ours according to Guenée. The many specimens we have bred and captured show comparatively little variation. The color of the basal half of the front wing is bright yellow, speckled more or less intensely with ferruginous or brown. The posterior half is deeper, with olivaceous and brown shades, and with more or less of lilaceous. The hind wings are dull-yellowish, more or less shaded with reddish-brown. The markings are withal so unique, as shown in the figure, that the species cannot well be confounded with any other.

During winter the time elapsing from hatching to maturity has averaged, in our vivaria, about seven weeks, but development will be much more rapid during summer.

Should the Urena ever be cultivated for its fiber, this its chief enemy will readily be destroyed by the same methods adopted against the Cotton Worm.

DESCRIPTIVE.

ANOMIS EROSA, Hüb.—*Egg.*—Diameter 0.8^{mm}, circular, flat below; the upper surface varies somewhat in convexity, in some being almost hemispherical, whilst with others it is quite flat, in general shape and size reminding one of the egg of *Aletia xylina*. Color, pale yellowish-green, almost of the same shade as the lower side of the leaves. The number of ribs which run from the base toward the summit varies in different eggs from 31 to 38. Of these ribs from 11 to 13 reach to about one-fourth the distance above the base, 5 to 7 half way toward the summit, and 16 to 18 to near the summit. The space between these ribs is divided quite constantly by 12 low transverse ribs, which at the intersection with the radiating ribs form a small though quite sharp triangular point, which is especially conspicuous in the empty egg. The spaces between these ribs form shallow, squarish depressions, which are finely granulated. The summit is almost smooth, surrounded with three series of small, roundish cells, which become larger away from the center, and beyond these another series of three rows of larger cells of different shapes, though more or less squarish.

LARVA.—*First stage.*—Length of the newly-hatched larvæ, 2^{mm}. Color very pale greenish-yellow along the dorsum, white and transparent toward the sides; head pale yellowish, without any markings; eyes black, tips of mandibles brown. Antennæ short, 3-jointed; first joint stout, very short and somewhat conical; second joint longest, clavate, its tip obliquely truncate externally, bearing at inner and outer angles a stout spine, which is a little longer than the third joint; third joint shorter than second, cylindrical, with a small tubercle at tip, resembling a fourth joint, and provided at its tip with a fine hair; at the inner side of the third joint, at base of the apical tubercles, arises a stout spine which is almost as long as the joint itself. Piliferous warts, pale brownish, each bearing a long and slender pale hair. Legs rather long, white; only two pairs of prolegs, situated on abdominal joints 8 and 9.

*Hist. Gen. d. Ins. Lep., Noctuélites, II, p. 395.

Second stage.—The first molt takes place seven or eight days after hatching; at this time the larvæ differ from the newly-hatched specimens only in the somewhat larger size and slightly darker color.

Third stage.—In from six to seven days the second skin is cast, and with this molt appears the third pair of abdominal legs on joint 7. They are, however, extremely small and scarcely noticeable; they are not used in walking. The color now is a darker green, lighter toward the sides, and with a pair of rather indistinct whitish dorsal stripes. Head highly polished, pale, faintly greenish, with two pale, dusky oblique stripes. Cervical shield slightly dusky, with a darker posterior margin. Piliferous warts black, the hairs colorless. The abdominal legs are marked externally with a broad dusky stripe.

Fourth stage.—The third skin is cast six or seven days after the second molt. The larva is now almost of the color of the leaves, and measures about 14^{mm} in length. The median and somewhat wavy lateral lines are darker than the rest of the body; the subdorsal stripes and sutures between the joints are white. The prolegs on abdominal joint 7 are now quite distinct, though rather small, and are used in walking.

Fifth stage.—The fourth skin is cast three to five days later, the larvæ having changed very little in appearance, except that the dorsal and lateral lines and the piliferous warts are distinctly dusky.

Sixth stage.—Five or six days later the fifth skin is shed, and the larva does not change in appearance.

Seventh stage.—The sixth molt takes place about five days after the fifth, and the whole appearance of the insect is considerably changed. The color is pale, translucent, pea-green. The head is not polished, of the color of the body; the two oblique dusky stripes are composed of several irregular spots; the labrum is white, antennæ pale greenish, and the eyes black. The median and the two subdorsal lines are composed of numerous irregular spots of a lemon-yellow color, of which those on median and the lower dorsal lines have a more or less distinctly dusky shade on either side; the lateral line is quite broad and almost white. Piliferous warts pale yellow, surrounded by transversely oval, indistinct, dusky rings. The whole body is speckled with numerous, usually transversely oval, small, lemon-yellow spots, which inclose from two to three almost colorless, glistening, round dots. Stigmata orange. Legs pale green; claws and hooklets pale brown; venter bluish-green.

Length of full-grown larva about 35^{mm} (1⅜ inches).

Pupa.—Length, 15^{mm}. Color, blackish-brown; wing-sheaths opaque, the remaining portion faintly polished. Front of head prolonged into a short, stout, conical projection; near its base ventrally are two fine and quite long hairs and two similar pairs dorsally near insertion of antennæ. Eyes prominent and considerably polished. Legs reaching to tip of wing-cases; antennæ shorter. Median line of prothorax quite sharp and carinate, median line of mesothorax faintly elevated, somewhat polished. The whole anterior portion of body finely and closely granulated. Metathorax and the three following abdominal segments, with numerous shallow, circular depressions, each having a central granule. The circular depressions on abdominal joints 4–8 are somewhat larger and their margin is slightly elevated; the posterior third of joints 4–6 is of a lighter color than the rest of the body and very closely and quite coarsely granulated, while the posterior third of abdominal joints 7 and 8 is polished and not granulated. The last joint is very peculiarly formed; its tip is broad and prolonged each side into a short, stout, and sharp tooth directed forward, and between these two is a pair of slender and also bristle-like spines, directed forward and with their tips curved in the shape of a loop; another pair of similar bristle-like spines, which are directed forward and inward, are situated, one at each side, on a small projection at the base ventrally of the stout lateral teeth, and between these is a large projection which is armed at its edge with two large, stout, claw-like teeth, which stand at right angles to the body of the pupa. The anal swelling is smooth, circular, and quite prominent; the remaining portions of the tip are marked with coarse, elevated ridges, both dorsally and ventrally.

THE CLOVER LEAF-BEETLE.

(*Phytonomus punctatus* Fabr.)

Order COLEOPTERA; family CURCULIONIDÆ.

[Plate X, Fig. 1.]

HABITS OF THE GENUS.*

During the year another European insect has made its appearance in the role of an enemy to an important branch of American agriculture. This insect—the *Phytonomus punctatus* of Fabricius—has been well known in Europe for almost a century, but has never done any serious damage to crops. Yet so common is it there that almost every one entomologically inclined who has traveled through Germany or France has doubtless found it under sticks or stones in pastures and meadows.

In looking up the literature on the habits of the insects of this genus in Europe, we find much written on the history of the earlier states of several species. From what is known in Europe, it appears that the species of the genus show a variety of habit and mode of development. The greenish larvæ (recalling in general appearance those of Syrphus or certain Tenthredinid larvæ) feed in May or June on the leaves and flowers of the plants they infest, and spin in July a net-like cocoon on various parts of the plant, changing therein to pupæ within eight or twelve days, the beetle issuing in July or August. Only one annual generation is recorded—the beetle hibernating.

Phytonomus murinus Fabr. oviposits on the young shoots of Lucern (*Medicago sativa*). *Ph. meles* Fabr. feeds as larva and beetle on the common red clover (*Trifolium pratense*) and on Lucern, and proves injurious to the latter plant in some parts of Germany. *Ph. nigrirostris* Fabr. (which by the way occurs also, though rarely, in the United States from Canada and Massachusetts westward to Michigan) feeds as larva on *Trifolium pratense* and *Buphthalmum salicifolium; Ph. pollux* Gyllh. on *Silene inflata* and *Polygonum hydropiper; Ph. rumicis* Fabr. on various species of *Rumex* and also on *Polygonum aviculare; Ph. viciæ* Gyllh. on *Vicia sylvatica; Ph. plantaginis* De G. on *Plantago lanceolata* and *Lychnis dioica; Ph. polygoni* Linn. on young shoots of *Dianthus* and on *Pylygonum aviculare*, the larvæ feeding on the leaves as well as on the blossoms, and also boring in the stems; *Ph. suspiciosus* Hbst. on *Lotus uliginosus* and *Lathyrus pratensis; Ph. palumbarius* Germ. on *Mentha aquatica* and *Salvia glutinosa*.

So far as heretofore known the habits of the genus in this country conform to the above experience in Europe. We have reared *Ph. comptus* Say from *Polygonum nodosum*, upon which the larvæ and pupæ may be found in July, the cocoon having the usual net-work appearance. Of the nine species known to occur in this country this and *Ph. eximius*† Lec., the habits of which were briefly given by E. A. Popenoe (Trans. Kans. Acad. Sci. 1877, p. 38) are the only ones (exclusive of *Ph. punctatus*) whose habits have been observed, though, as above shown, those of *Ph. nigrirostris* have been recorded by European observers.

HISTORY OF THE SPECIES IN NORTH AMERICA.

Concerning the appearance of *Ph. punctatus* in this country we stated in the *American Naturalist* (in which we have recorded the above facts)

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*Compiled from contributions to the American Naturalist.

†According to Professor Popenoe the larva feeds on *Rumex britannica*, and transforms in a similar cocoon on the plant.

for March, 1882, that Dr. Le Conte received a beetle as long ago as 1853 from Canada, from Mr. D'Urban, who was then connected with the geological survey of that country, and another specimen from the late Dr. Melsheimer, from Pennsylvania, and that these specimens had been described by him as *Phytonomus opimus* (Rhynchophora, p. 124). He had recognized, from what we had published in the Naturalist, for November, 1881, regarding *Phytonomus punctatus*, that his *opimus* was identical, and upon receiving specimens from me he wrote that, after a careful examination, there was no doubt in his mind as to the identity of the two species. *Ph. punctatus*, in its typical and most common form, is so easily recognizable by its coloration (the suture and margins of the elytra being yellowish-white) that one would not suspect its identity with *Ph. opimus* from the description of this last.

It would appear, however, that *opimus* is identical with a variety of *Ph. punctatus* described by Capiomont (*Annales de la Société Entomologique de France*, 1868, p. 123), in which the scales of the elytra are almost uniformly gray, and which is not rare in Europe. The specimen from Melsheimer is, moreover, evidently rubbed. It is a strange coincidence that the numerous specimens we collected on Mr. Snook's farm were all identical in coloration with the typical form, and that just those described by Dr. Le Conte as *opimus* should belong to a comparatively rare form.

The identity of the two forms once established, it becomes probable that the insect had made a permanent lodgement in this country years ago, and that it was simply overlooked as an injurious insect till last year. That a beetle is quite liable to be overlooked by Coleopterists, although quite injurious to some cultivated plants, is not only probable, but has often occurred. *Coccotorus scutellaris*, which injuriously affects the Plum; *Tyloderma fragariæ*, which depredates on the Strawberry plant; and *Hylesinus trifolii*, which is so injurious to clover, are examples among many which occur to us of species very common on cultivated plants, yet rare in collections. The same is equally true in other orders of insects. A notable instance is found in the Hessian Fly, which, though more or less injurious every year in some of our wheat-producing sections, is yet so rare in collections that Dr. Packard had much difficulty in procuring specimens to figure for his bulletin on the species.

There is the other alternative, however, (which is also not so improbable), that the two specimens that have remained solitary so many years in the largest American collection of Coleoptera may really have come into the country through European exchanges, especially as it is known that Dr. Melsheimer did in some instances mix up European and American species.

Our attention was first called to this insect by letter from Mr. L. D. Snook, of Barrington, Yates County, New York, in July, 1881, stating that great damage was being done to the clover on his farm. In the latter part of April he first noticed on a field of clover, here and there, small patches where the leaves were badly eaten. The damage increased rapidly in extent, and by the end of July the whole field (about seven acres) was badly infested, one corner of nearly two acres having scarcely a whole leaf of clover remaining. Other fields in the same neighborhood were attacked in the same manner, while an occasional field escaped injury.

We visited Mr. Snook in August of 1881, and found acres of his clover ruined, but in passing through the field none but an expert would suspect the cause, since the beetles were, as a rule, hiding in the ground or slightly beneath the surface, and the few that were feeding dropped and "played 'possum" upon the slightest approach, their color being so nearly that of the earth that they are not easily observed. That they had been much more numerous earlier in the season than they were then was apparent from the number of dead specimens, more or less broken, and from the cocoons imbedded in the ground. No traces of eggs, larvæ, or pupæ were found, though many empty cocoons were obtained either on the surface of the ground or imbedded just in the ground, as we then supposed, from the battering of rain. None were found upon the plants.

In June of the present year we sent Mr. E. A. Schwarz to Barrington to look after the progress of the pest. His report shows an alarming state of affairs in Yates County, the insect having spread in all directions. He writes as follows on this point:

Upon my arrival at Mr. Snook's place at Barrington, N. Y., (June 13), I found that the field where the weevil was first discovered had been ploughed about a fortnight ago; but a few isolated plants growing near the fence of this field proved to be infested with the insect. Two clover-fields near by harbored countless specimens of the insect (now mostly in the larva state), while other more distant fields were in similar conditions. I traced the insect for about one mile from the original field toward Crooked Lake without finding that it became less in numbers. Further investigations showed that it not only infested the clover in the fields and on pasture lands but the isolated plants growing in the gardens and on the roadsides. It is no exaggeration to say that I had difficulty in finding a clover plant that was not infested. Continuing my researches at Dundee the next day I began by finding the Phytonomus in the middle of the town on the clover plants in the gardens, along the roadsides, in the ditches, and upon going in the fields in the direction of Rock Stream I found the same condition as at Barrington. Upon my return trip I noticed the presence of the insect at Starkey, on the Northern Central road, three miles east from Dundee, and finally found the larvæ, upon a hasty investigation during rainy weather, under clover plants growing along the roads near Watkins, N. Y., about fourteen miles from Barrington.

From these facts it may be assumed that the pest is at present much more widely distributed than it was suspected from last year's observations.

Since last fall numerous experiments in rearing this insect have been carried on in the Division, and from the notes, as well as from this year's observations in the field, we are enabled to give the following life-history of the species:

LIFE-HISTORY OF THE SPECIES.

The smooth, greenish-yellow, oval eggs are deposited by the female beetle in irregular clusters, mostly in the hollow leaf-stems or flower-stalks, where such situations can easily be found, or they are pushed into crevices near the base of the plant. In confinement the females lay their eggs promiscuously upon the glass and wood work of the breeding-cages, or upon almost any part of the plant given them for food. When deposited upon a plane surface, however, they are not firmly attached and are easily removed, which argues that their natural location is in some crack or hollow.

The newly-hatched larvæ are pale yellow in color, and feed preferably upon the under side of the leaves, or between the young leaves before these get separated, eating small, round holes. While feeding the body is somewhat curved and the larvæ evidently hold to the hairs of the leaf by the folds between the joints of the body, as they are entirely legless. As they increase in size they acquire a greenish tinge, the broad dorsal stripe alone remaining whitish. A few of them, however, retain the pale-yellowish color throughout their development. After the third molt they feed at the sides of the leaf, eating out large irregular patches, as shown in our figure. (Pl. X, fig. 1 *b*.) The shape of the larva at this time is also so well indicated at *b* and *c* as to need no further description. The whole length of the larval life in the breeding-cage varies from forty days in summer to several months in winter and fall.

Only the very young larvæ can be observed upon the plants, the older ones invariably dropping to the ground when approached. Most of the larvæ, however, do not feed on the plants during the daytime, but are to be found under all sorts of shelter in or on the ground, sometimes quite a distance from the plant, but preferably among the roots and old stalks. Here they lie curled up in a similar manner to our saw-fly larvæ or cut-worms. When handled they often eject, in a long stream, their semi-fluid, pitchy-black excrements, probably as a means of defense. When teased they finally stretch out and walk off more rapidly than could be expected of a legless Curculionid larva. When crawling they not only use the ventral tubercles, which are very prominent, resembling legs without the claws, but they use also the head and anus in a very peculiar manner. The head is pressed downward until the front touches the ground. The body is thus stretched forward as much as possible when the anus leaves its hold, quickly following the rest of the body and taking a firm hold near the head. The larva then stretches itself out, and the same movements are repeated. The anus evidently plays an important part in the locomotion; it is somewhat extensile, and each time the larva uses it to take hold of the leaf a small drop of a sticky fluid is ejected. The anus seems also to possess the power of suction as the larvæ are capable of erecting themselves so as to look around for some object to take hold of, turning, at the same time, their bodies in all directions and holding solely by the anal end.

Toward evening the larvæ begin to be more active and ascend the plant, undoubtedly continuing to feed throughout the night. However, even at dusk they do not become less timid than at daytime, and can only be observed upon the plants at a considerable distance, curling up and dropping down when approached. Their favorite position is with their bodies around the edge of a leaf, but more rarely one may be seen stretched out on the surface of a leaf.

The damage done by the larvæ in the month of June was already quite considerable, the presence of four or five half-grown ones being sufficient to give the plant a ragged appearance, and in some places where the plants were completely defoliated, not less than 32 larvæ were counted under one plant, which was not a very large one.

After feeding for from ten to fifteen days, having suffered three molts, the larva commences to spin its cocoon. The cocoon is oval, pale yellow in color, and is composed of coarse threads forming an irregular net-work, as shown at *f* and *g* in the figure. In the breeding-cages (during the winter of 1881–'82) it was usually spun between two or more leaves or leaf-stalks and attached to them. This is in accord with what is recorded on the subject by European writers, but all the old cocoons we found in 1881 were either on or in the ground, and Mr. Schwarz found them in June, 1882, invariably under ground, *i. e.*, so completely covered up with soil that in clearing away all *débris* no trace of them could be discovered from above. Usually they were just covered with the soil, but in some instances they were more than half an inch in the ground, each cocoon lying in a nicely-smoothened cavity. This habit, though different from the known habits of other species of the genus, is undoubtedly normal with *punctatus* in the field

In spinning among leaves the abdomen bends under, and the larva is thus able to brace itself with two points against the fastened leaves, whereby the head and front portion of the body can be easily moved in every direction; it then touches with its mouth the leaf, applying at the same time a drop of a transparent, pale-yellowish liquid, which is stretched out to a thread until the next point is reached with the mouth. In this way it continues for some time, and then turns the body in another direction, and works in the same way until a nearly oval cell is formed; when this is done it fills up the space between the meshes more and more, and the cocoon becomes more regular. It then follows the different threads with its mouth to strengthen them with additional applications, and at the same time fills up the too large spaces till the cocoon is quite compact, leaving only small, round, or oval holes through which the larva is but indistinctly seen. The spinning of the cocoon lasts for about one day, when the larva ceases to work and remains lying in a more or less curved position until it finally casts its last skin to transform to a pupa.

Mr. J. A. Osborne, in an interesting note on *Phytonomus rumicis*, in the *Entomologists' Monthly Magazine* for June, 1879, states that the spinneret of the larva is anal. Be this as it may, *Ph. punctatus* spins with its mouth, bracing itself against the part of the cocoon already formed while constructing the remainder. The silk issues from the spinneret in a very perceptibly liquid condition, but soon hardens, and the thick threads forming the walls of the cocoon are coarse, tough, and strong. The length of the pupa state in late fall is about twenty-five days.

As will perhaps have been gathered from the preceding, the principal damage is done by the insect after it arrives at the perfect or beetle state. The beetle is very voracious, and devours the leaves at a rapid rate, eating the flower heads and stalks and also the leaf petioles—in fact all parts of the plant above ground. It feeds principally late in the afternoon and at night, and during the daytime generally hides itself around the roots of the plant or in some crack in the ground. It is easily disturbed when feeding, drawing up its legs, dropping to the ground, and remaining motionless for some time.

This Phytonomus feeds upon all sorts of clover, on the white as well as upon the different varieties of red clover, and apparently without any special preference for any variety.* It thrives well on every kind of soil, and the only locality of any extent so far examined in Yates County where the insect was not found was a steep slope at the edge of a field, where the clover was most luxuriant and the soil very rich and soft.

Our notes on the length of life of one generation of the beetle (taken from specimens kept in breeding cages at Washington in the fall of 1881) give the following result: The eggs hatch within from nine to twelve days after being deposited; the first molt of the young larva takes place eight or ten days after hatching; the second molt takes place seven to ten days after the first; the third molt eight to ten days after the second. The time elapsing between the third molt and the formation of the cocoon is very variable, one larva beginning to spin 17, another 24, a third 28 days after the third molt, while with a fourth 31 days elapsed. The cocoon is finished in about one day, the larva remaining therein unchanged from seven till ten days. The beetle issues about one month later. Thus it takes almost four months from oviposition to the hatch-

*The Clover Root-Borer (*Hylesinus trifolii*) seems to feed only upon *Trifolium pratense*. It was never observed upon white clover, nor did it attack, on Mr. Snook's farm, the Alsike clover (*Trifolium hybridum*).

ing of the beetle. In summer time the insect no doubt develops more rapidly, as beetles issued in the last days of June from cocoons spun about the 20th of that month.

NUMBER OF ANNUAL BROODS.

The beetles which were so injurious in July and early August laid eggs in the latter month, and the larvæ issued in September, transforming in October or November, and appearing as beetles in the latter month. A portion of these beetles, without doubt, hibernated as such without ovipositing; others laid their eggs, and there is strong reason to believe that certain of these hibernated, as a flower-stalk was received as late as January 28, from Barrington, which contained a well-developed egg-cluster. Many eggs hatched in the same fall, the young larvæ doubtless hibernating within the old stalks.

Mr. Schwarz found, on June 13 and 14, the insect in all stages except the egg state, by far the most common form being the half-grown larvæ, then following very young larvæ, then full-grown larvæ, then the cocoons, which were all freshly spun (not one containing the pupa), the rarest form being the beetles. There can be no doubt that the beetles then found were all hibernated specimens, since they were all very much rubbed. A large portion of the larvæ reached maturity and spun up by the 20th of the month, and at the date when this report is submitted, (June 30) the beetles have been issuing for four days. The younger larvæ (which in all probability come from eggs laid this spring by hibernated beetles) will not reach the perfect state before the end of July or perhaps some time in August.

We have thus followed the development of the species for nearly one whole year, yet it is impossible to say whether or not it is regularly single or double brooded. In considering the number of annual generations in any species we have to bear in mind that there is great irregularity in development, which is also much influenced by the character of the season. We have strong reasons for believing that during a severe and protracted drought, such as we had in the late summer and fall of last year, multiplication in this species comes pretty much to a standstill, and our first observations in August showed that the species occurred in none of the earlier states. This fact, together with the other well-known fact that the *Rhynchophora* in the imago state are often long-lived and do not begin ovipositing immediately after maturity, leads us to believe that there is normally but one annual generation, and that the beetles which are perfected during the months of June and July beget a generation which either hibernates in the immature or the mature condition, according as it is developed earlier or later.

While this would seem to be the rule, as we know it to be with many other Rhynchophora, yet our notes and observations as here recorded would indicate that a second generation may exceptionally occur. In other words, the monogoneutic generation of one year may become digoneutic the following year, because of the irregularity in the development of the individuals. The only thing that becomes certain in this uncertainty is that the larvæ are in greatest and most destructive force during the latter part of May and in June; that the new generation of beetles work during July and August, so far as we now know, without propagating, and that only a portion of their issue that is found in the larva state later in the autumn attains the perfect beetle state before winter sets in, when brought to a more southern latitude like that of Washington; the presumption being that in Yates County, New York, all would remain in the earlier states and thus hibernate.

REMEDIES.

It is impossible to say whether or not this Phytonomus will spread farther. The encouraging presumption, however, is, if we may predicate upon analogy, that it will not, since we recall no very injurious beetle introduced from Europe (excluding those feeding upon stored products) which has spread over the whole country, the most prominent examples of such introduced species, *Crioceris asparagi*, *Galeruca xanthomelæna*, &c., being yet confined to the Atlantic coast.*

Our experience and observations during the winter show that this Phytonomus hibernates principally in the young larva state, and that any mode of winter warfare that would crush or burn these larvæ hibernating in the old stalks would materially reduce the depredations of the species the ensuing summer. Clover stubble is, however, not so easily burned in winter, and whether rolling could be advantageously employed will depend very much on the smoothness of the field and other conditions.

The extreme timidity of the larva as well as of the beetle, and the protected position of the insect in all stages render the application of pyrethrum, or any other remedy acting upon contact, entirely useless. To poison the clover with London purple or Paris green would no doubt be effective, but can be safely applied only wherever the clover is not used for fodder.

Should the Phytonomus be very bad in a field, it would be well to plow the clover under rather than to allow such field to become a source of contagion. This should be done in the month of May, when the insect is mostly in the larva state, and when all eggs from the beetles that hibernated have been hatched. To plow the field when the Phytonomus is in the imago state would have no other effect than to disperse the beetles over other fields.

NATURAL ENEMIES.

Of the various species of Ichneumon flies known in Europe to prey upon the larvæ of Phytonomus, none have been observed so far in this country, and to this immunity from the most efficient natural checks the undue multiplication of the species is no doubt to be attributed. Of other insect enemies only one has been actually observed so far, viz., the larva of a small beetle, *Collops quadrimaculatus*, which was found feeding upon the eggs sent from Barrington in January. Mr. Schwarz found three dead larvæ on the plants, and from the manner in which they were killed he thinks that they were sucked out by Soldier bugs, several species of which were seen in the fields, but none in the act of sucking Phytonomus larvæ. Several ground-beetles (*Harpalus pleuritious*, *H. pennsylvanicus*), a *Pterostichus* larva, and numerous specimens of a large red mite (genus *Trombidium*) are found under the infested plants, and these probably prey upon the Phytonomus in its earlier stages, but no proof thereof can be given at present. Ants do not seem to trouble the larvæ, as on several occasions specimens of the latter were found in the middle of the ants, which build their colonies under small stones and sticks in the field. This species is in all probability

* As an interesting fact in connection with imported clover enemies, we would mention that several species of the Curculionid genus *Sitones*, especially *S. flavescens* and *lineellus*, which in Europe are injurious to clover and lucern, and which have long since become naturalized in our country, have never been reported here as injurious, though they occur quite commonly in some localities.

extensively fed upon by Tiger beetles (*Cicindelidæ*), which, both in the larva and beetle states, doubtless attack and devour the Phytonomus larvæ, whether when they feed or crawl over the ground, or in the ground to pupate; for we found, during August, on Mr. Snook's farm, that the ground in the infested clover-fields was in many places literally riddled with holes of larvæ of *Cicindela repanda*, most of them apparently nearly full-grown, and many just having changed to the perfect beetle.

DESCRIPTION OF EARLIER STATES.

PHYTONOMUS PUNCTATUS—*Egg*.—Length, 1^{mm} ($\frac{1}{25}$ inch). Elongate oval, rather more than twice as long as thick, cylindrical, highly polished, and without any apparent sculpturing when recently deposited. Color pale yellow. When about five or six days old the color changes to a quite dark greenish-yellow, and the egg appears to be quite rough, an examination under the microscope showing that the whole surface has divided into numerous hexagonal, shallow depressions.

Larva—First stage.—Length, 1.5^{mm}. Body somewhat thickest at the middle, tapering gradually toward the ends. Color pale yellowish, head blackish-brown, polished, with fine transverse wrinkles; eyes black, small, round and projecting; antennæ short, 2-jointed; first joint very short and very stout; somewhat conical, with the tip externally oblique, and with two short spines on its distal side near the base of the second joint; the second joint very slender compared with the first, but almost twice as long, tapering gradually towards the tip, where it forms a short nipple, curved slightly upwards; a long, stout bristle above, near inner angle of base of antennæ; mandibles light brown, with basal two-thirds very broad, terminating in two large, sharp teeth, one above the other, the edge of the lower one being armed with three minute rounded teeth; palpi pale. Cervical shield dusky, narrow, divided by a pale dorsal line. Spiracles dusky, oval, with transverse wrinkles. The whole dorsal surface is closely covered with minute, sharp, transversely oval, slightly dusky points. All joints have small, conical, dusky warts, as follows: 8 dorsal, the outer four quadrangularly arranged, the inner four much the smallest; there are two additional lateral warts, one above the other, on the thoracic joints, and one lateral wart on each of the abdominal joints; each of these warts bears a very conspicuous clavate spine. The ventral side of the body is similarly armed, though the spines are more slender. There are no legs, but in their place are very prominent swellings. Those of the thoracic joints are conical, and those of the abdomen are somewhat transverse, and each of them is longitudinally subdivided so as to form two rounded swellings, which are used in grasping when walking. The end of the body is divided into three round lobes or swellings, which surround the anal opening, one above and two below.

Second stage.—General appearance very similar to that of the previous stage, except that the color has become greener; the head, which at first is yellowish-brown, is now dark brown; the cervical shield is of the color of the body, with the front margin and lateral angles more or less blackish; the clavate spines are somewhat shorter, but the principal feature is a broad whitish dorsal line which on each joint is bordered by a more or less distinct small blackish streak.

Third stage.—The appearance is not much changed, except that the dorsal line and its bordering blackish streaks are more distinct; the head is at first pale greenish-yellow, and gradually changes to brownish; eyes deep black; the anterior margin of prothorax is lined with twelve blackish warts; all other joints are divided into two very distinct folds, of which the anterior ones bear each side of the dorsal line a blackish wart, the posterior a transverse row of twelve warts and two lateral warts; all these warts bear short, quite stout clavate bristles or spines, those on the lateral warts being somewhat longest. There is a pair of simple and longer spines on joints 10 and 12; all spines on ventral side of the body are also simple.

Fourth stage.—The larvæ are now quite dark green, especially the anterior half of the body, the posterior half having a lighter and more yellowish color, especially along the lateral margin, and the last two joints are tinged with brown. The dorsal line is very distinct and of a very pale rose color; its lateral borders are black, forming two quite broad interrupted lines; head brownish. The whole surface of the body, above and below, is very rough; the thoracic and abdominal swellings are very prominent, and have a great resemblance to legs without the claws; the prothorax possesses three of these swellings, of which the middle one is the most remarkable; it forms a prominent conical tubercle, which at the tip is divided into two separate conical tubercles, with a stout, black, recurved bristle anteriorly near their base; similar but less conspicuous tubercles on the other thoracic joints; joints 4–11 each with two pairs of similar tubercles. Length of the fully grown larva when stretched, about 14^{mm}.

Pupa.—The form of the pupa is well represented in the figure (Pl. X, Fig. 1, *h*). Its rostrum, antennæ, legs, and wing cases are yellow; head yellowish-green; abdomen dark green, with a pale flesh-colored dorsal line, the sides and venter somewhat paler; eyes very small and black. These are the colors soon after transformation. The front of the head has a deep longitudinal impression, and there are two deep transverse impressions near the middle of the pronotum. Head and thorax sparsely hairy; wing cases with nine deep striæ; abdominal joints each with a transverse dorsal row of short, bristle-like hairs, and quite a number of hairs around tip of abdomen.

THE VAGABOND CRAMBUS.

(*Crambus vulgivagellus* Clem.)

Order LEPIDOPTERA; family CRAMBIDÆ.

[Plate X; Fig. 2.]

HISTORY OF ITS INJURY AND IDENTIFICATION.

Early in May, 1881, considerable damage was done to meadows in the vicinity of Watertown, Jefferson County, New York, by an insect which was popularly thought to be the Army Worm. Specimens were sent to us in May last by Mr. J. Q. Adams, of Watertown, and by Professor Lintner, the State entomologist at Albany, N. Y.

The worms sent by Professor Lintner, and which he was not quite sure were the Army Worm, were chiefly the larvæ of *Nephelodes violans*, an account of which, with figure, we had prepared for this report, but which, among other things, we have been obliged to exclude for want of space. Those sent by Mr. Adams were partly Nephelodes, but chiefly the Crambus under consideration, which proved to be the principal author of the damage. On July 2nd Professor Lintner wrote us:

I have just handed in to the *Evening Journal* a correction and explanation of my reference of the ravages in Northern New York to *Nephelodes violans*. From examples of the cocoons and information sent me by Mr. Adams, I find that the work is due, as I had lately suspected, to the small larva, which I have determined as that of *Crambus exsiccatus*.

On the 5th of the same month we wrote Professor Lintner:

I have just read your article in *Journal* of the 2d. I have some reasons for believing that your *Crambus exsiccatus* was an accidental larva different from the Pyralid which in every instance is yet in the larva state (not parasitized), and the long larval life in the cocoon is so common in the Pyralidæ.

We first reared the moth on August 2, and early in the month informed both Mr. Adams and Professor Lintner that the destruction was done without doubt by *Crambus vulgivagellus*.

Mr. Lintner studied it in the field, and presented a lengthy report upon it to the State Agricultural Society in September (published in the *Elmira* (N. Y.) *Husbandman* for September 14). He also read a paper upon it before the American Association for the Advancement of Science, in August, at Cincinnati.

Later in the season we found the moth very abundant in all parts of the Eastern States which we visited, and it was so common in the vicinity of New York as to be a positive nuisance in collecting, as we were informed by Mr. Henry Edwards (see *American Naturalist*, November, 1881, p. 914). It was also present in large numbers in the District of Columbia, where the fall larvæ were studied.

HABITS AND NATURAL HISTORY.

The eggs are difficult to find, as they are dropped singly by the moth wherever she happens to rest, and the slightest jar causes them to fall into some crack or crevice. The larvæ, if not too numerous, are also difficult to find, on account of their nocturnal habits, but more particularly from their secluded mode of life. From the time of hatching to the assumption of the pupa state they remain nearly in the same spot. The newly-hatched larva spins a delicate white web, near or among the roots of the grass, and commences at once to feed upon the softer parts of some leaf near at hand, or bore through its surrounding sheaths into the stem itself, near its base. Whenever they have settled they protect themselves by a delicate web, which they gradually cover with their greenish frass, forming a tube, in which they are entirely hidden from view. They are very sluggish, and, if the tube be disturbed, curl up into a helix-like roll. As they increase in size the tube is extended either upward, when upon the ground, or downward, if somewhat above the surface, and the opening is often lined with bits of green grass. When the larva is full grown its tube measures, often, nearly 50^{mm} (two inches) in length. A half inch at the lower end is thicker than the rest, is rounded and closed, serving both as a retreat for the larva and as a receptacle for excrement. The upper or open end is usually very delicate, and is generally so constructed that if the larva is disturbed and moves downward it closes entirely.

When full-grown and ready to transform, the larva leaves its tube and commences to spin among the roots, and near or just beneath the surface of the ground, an elongate club-shaped cocoon, similar in appearance to the lower end of the larval tube. It is composed of smooth and delicate white silk, gummed over with earth. Both ends are rounded, the thicker end being about 6^{mm} in diameter, and the narrower end about 4^{mm}. In this cocoon the larva remains for a long time before transforming. Mr. J. Q. Adams, of Watertown, states that while every larva was inclosed in a cocoon by the last of May, an examination as late as July 15 failed to show any change to pupa. By August 15, however, the moths began to issue in large numbers, and, as Mr. Adams says, "at this date, August 22, any farmer of the country can walk his meadow or pasture and drive up moths in countless numbers, or, in places, in a small cloud."

There can be little question that other species of the genus are associated in moderate numbers with the Vagabond Crambus, and the breeding of *Crambus exsiccatus* by Professor Lintner so much earlier in the season would indicate that there is considerable variation in the period of development between them.

Naturally, the moth is rather shy if disturbed, though as a rule it will not fly very far, and when at rest may be approached quite closely. It seems to prefer dry stems or leaves of grass or weeds when alighting, and it is very difficult to detect in such situations, owing to the similarity of its color to that of the object upon which it rests. It swoops suddenly to the ground when startled, but does not feign death, as do so many allied insects. Instead, it slips, with a peculiar gliding motion, under the dry leaves or other objects upon the surface of the ground, or even makes its way into cracks of the soil.

The number in which these worms must have appeared to do the damage reported is enormous. Some pasture lots of 40 acres were entirely ruined, and as many as a dozen worms were often found in a space as big as the palm of a man's hand. Mr. Lintner, in his paper read before the American Association for the Advancement of Science, at Cincinnati, stated that on an island in the Roquette River, which had been absolutely denuded of grass, the worms had so thickly congregated under the shade of a solitary oak tree that its base for about 18 inches was covered with a fine layer of silken web. The worms had evidently been forced, from sheer lack of food and shade, to migrate, and they naturally collected under the first shade in their way, constantly spinning, as is their nature, until the compact web was formed.

The injury, he stated, extended over eight of the northern counties.

Hundreds of acres of grass presented a brown appearance, as if they had been winter-killed. A pasture lot of fifty acres, which ten days before offered good pasture, was burned so that in places not a blade of grass could be seen to the square yard. Numerous dead caterpillars were adhering to the dead stems of last year's grass, which it was believed had fallen victims to starvation. The upland pastures were first attacked. The progress was remarkably rapid; entire fields were laid waste in ten or twelve days. * * * In two instances the larvæ were observed in immense numbers collected on the trunks of trees, so that they could have been scraped up by handfuls.—(*Canadian Entomologist*, September, 1881, p. 182.)

We reared two different parasites from the species; one of them *Lampronota frigida* Cr., the other a *Cryptus* not yet specifically determined.

SIMILARITY OF HABIT IN A EUROPEAN SPECIES.

Curiously enough, Mr. William Buckler, during the same year, has worked out the life history of an English species, *Crambus warringtonellus*, and it corresponds perfectly with the observed facts in relation to *vulgivagellus*. The eggs were received August 14 and 22, and had all hatched by September 1. The progress of the larvæ was noted up to the middle of November, when they began to close their galleries for hibernation. They began work again early in the spring of 1881, and issued as moths from July 7th to the 17th, some of the larvæ having become full-fed and having spun up by the end of May. (*Entomologists' Monthly Magazine*, November, 1881, p. 129.)

REMEDIES.

The moths which were so abundant in August laid their eggs in the latter part of that month and in September. Egg-shells were abundant in the earth from some sward sent to the Department September 14 by Mr. Adams from a field which had been greatly injured, showing that the larvæ must have hatched prior to that date. Moths collected at Washington October 13 deposited many eggs during the night, which hatched in from seven to ten days. The young larvæ began feeding and spinning their tubes almost immediately. Some had cast their first skin November 1, their second November 15, and their third December 12. At this point our notes upon their development cease, but they evidently hibernate in the larva state, and, as full-grown larvæ, do their principal damage the ensuing April and May. This proves, then, but a single brood in a season, and suggests the simple remedy of burning over infested meadows in the dead of winter, or, better, in the late fall.

DESCRIPTIVE.

The larvæ of *C. vulgivagellus* are slender, subcylindrical, and of a pale purplish-green color. The moth has an expanse of wings of 25^{mm} (1 inch); the front wings are very pale-yellowish, dusted with brownish between the veins, and the hind wings are somewhat dusky; the cilia at the edge of the front wings are golden. The principal variation is in the extent of the brown streaks upon the front wings.

Specimens of the moth from Vancouver's Island differ only in their somewhat smaller size. (*Can. Ent.*, 1880, p. 17.)

We append descriptions of the earlier states:

CRAMBUS VULGIVAGELLUS—*Egg*.—Length, 0.7^{mm}; diameter, 0.3^{mm}; color, pale yellow when laid; polished, elongate oval, slightly thicker and a little more flattened at lower end than at upper. There are about 18 quite sharp longitudinal ridges, the spaces between them shallow, and divided by numerous low transverse ribs; the color changes after three days to bright orange.

Larva.—Length when newly hatched about 1^{mm}; general color dingy yellow, with very pale, irregular, reddish markings. The head is large, and the body tapers gradually from it towards the end. Head deep black, and furnished with a few long hairs; antennæ white, 4-jointed; joints 2 and 3 are each furnished at their apical angle with a stout spine, that of joint 3 being longer than the joint itself; the last joint is very minute, bearing 2 fine hairs at tip. Cervical shield blackish, with 6 long black bristles along anterior margin, and 6 smaller hairs somewhat in front of posterior margin; the other joints are each furnished with a transverse row of 8 long, blackish hairs, arising from prominent, conical, somewhat dusky tubercles. Thoracic legs slightly dusky; abdominal legs white, long, and conical.

In the fourth stage the color of the body is quite dark and purplish, instead of pale as before; the cervical shield is black. Each joint has a transverse wrinkle across its posterior third; the piliferous swellings are large, oval, and faintly darker than the rest of the body, and the black hairs each arise from a small white wart, which is surrounded by a narrow black ring. Legs purplish, those of the thorax darkest with the tips of the joints white.

The full-grown larvæ vary more or less in size, though the largest measure about 18^{mm} in length; the color is pale purplish green, the head black, polished, with shallow, transverse wrinkles; the cervical shield brownish, with a few small blackish markings, and a narrow, whitish median line. The posterior wrinkle of abdominal joints is pilliferous, warts large, oval, brownish, somewhat polished; dorsal line narrow, of the same purplish color as the body, bordered each side by an irregular whitish line; interrupted subdorsal line broader and whitish in color; stigmata black, and shield brownish, slightly polished; venter pale.

Pupa.—Length 15 to 20^{mm}; color yellowish, polished; eyes black, not prominent; head curved forward, front somewhat projecting, rounded; stigmata brown; ventrally near the end, transversely flattened, and somewhat concave, the edge quite sharp and furnished with three fine straight spines.

BIBLIOGRAPHICAL LIST.

The following contains all the essential published references to the species, though various journals have had abstracts or repetitions, especially of Professor Lintner's articles:

CLEMENS, BRACKENRIDGE.—Proceedings Academy of Sciences, Philadelphia, 1860 p. 203.

[Original description of *Crambus vulgivagellus*.]

GROTE, A. R.—*Canadian Entomologist*, January, 1880, (Vol. XII, p. 17).

[Notes that specimens of *Crambus vulgivagellus* from Vancouver's Island are smaller than eastern specimens.]

LINTNER, J. A.—*Albany Evening Journal*, May 23, 1881.

[Personal observations on the supposed Army-worm. Doubts as to whether it is *Leucania unipuncta*. Statement that no descriptions of the earlier stages of the larva of this last exist to compare with.* Distribution and Ravages.]

LINTNER, J. A.—*Courier and Freeman* (Potsdam, N. Y.), May 26, 1881.

LINTNER, J. A.—*St. Lawrence* (N. Y.) *Republican*, June 8, 1881.

RILEY, C. V.—"Supposed Army-worm in New York and other Eastern States."—*American Naturalist*, July, 1881, p. 574. (Published the previous month.)

[An account of the method of work from J. Q. Adams, of Watertown, N. Y., of what he supposes to be the true Army-worm. Its determination by Mr. Riley as an unknown Pyralid which he had previously seen in Missouri in pastures.]

LINTNER, J. A.—*Albany Evening Journal*, July 1, 1881.

[Refers to the work of the species; shows that the insect supposed to be doing damage is not the Army-worm, but *Nephelodes violans*; refers to a second Pyralid larva which will probably prove to be *Crambus exsiccatus*, one of this species having been reared.

* This is a mistake. See our Mo. Ent. Rep. VIII (1876), pp. 184, 185.

ADAMS, J. Q.—"The late so-called Army-worm."—Watertown (N. Y.) *Daily Times*, August 22, 1881.

[Gives an account of habits of and damage done by *Crambus vulgivagellus*, comparing it to the true Army-worm.]

RILEY, C. V.—"The Genuine Army-worm in the West."—*American Naturalist*, September, 1881, p. 750. (Published the previous month.)

[In a foot-note to this article the author identifies the supposed Army-worm of northern New York as *Crambus vulgivagellus*.]

LINTNER, J. A.—"The Vagabond Crambus."—Elmira (N. Y.) *Husbandman*, September 14, 1881.

[An article read by Mr. Lintner before the New York State Agricultural Society, giving an extended account of the damage done by *Crambus vulgivagellus* in Northern New York in 1881, and the complete life-history of the species, except method of hibernation. The only remedy mentioned is attracting the moths to lighted kerosene upon the surface of water in barrels.]

SAUNDERS, WILLIAM.—*Canadian Entomologist*, September, 1881 (Vol. XIII, p. 181).

[A short review of Mr. Lintner's paper on *Crambus vulgivagellus*, read before the 1881 meeting of the American Association for the Advancement of Science.]

LINTNER, J. A.—*Ogdensburg* (N. Y.) *Daily Journal*, September 21, 1881.

[Common name of Vagabond Crambus proposed; remedies suggested.]

RILEY, C. V.—"*Crambus vulgivagellus*."—*American Naturalist*, November, 1881, p. 914.

[Remarks upon the abundance of the species in all the Eastern States in 1881, and describes the eggs.]

RILEY, C. V.—*American Naturalist*, December, 1881, p. 1009.

[A short review of Mr. Lintner's A. A. A. S. paper on "A remarkable invasion of Northern New York by a Pyralid Insect," objecting to the use of the term "invasion" in this connection.]

THE WHEAT ISOSOMA.

(*Isosoma tritici* Riley.)

Order HYMENOPTERA; family CHALCIDIDÆ.

[Plate XII, Fig. 3.]

PAST HISTORY AND HABITS.

"For nearly two years past I have been studying the habits of a new species of Isosoma which has been injuring wheat-stalks in Illinois, Tennessee, and Missouri. The larvæ were first received by me in June, 1880, from Mr. J. K. P. Wallace, of Andersonville, Tenn., who stated that nearly every stalk was affected, and that, as a consequence, the straw is inclined to fall before the wheat is fully ripe. I replied to his letter asking information, in the *American Entomologist* (III, p.181), stating that it was a new wheat enemy, evidently Hymenopterous. Professor Thomas had found the same worm that year in wheat in Illinois, and from having bred a two-winged fly (a species of Chlorops) from some collected stalks, wrongly attributed the parentage of the worm thereto. Professor Packard, during a trip made to Virginia and other Southern sections that same year, found this new wheat enemy tolerably common. The insect passed the winter either in the larva or in the pupa state, and the perfect fly issued in March and April, 1881. Specimens received the present year have issued in December and January, induced doubtless by the long-protracted warm weather.

"Although congeneric with the Joint Worm of Harris and Fitch, it differs widely from the latter in habits and appearance. The Joint Worm, it will be remembered, forms a gall-like swelling at a joint near the base of the stalk. The species under consideration, however, feeds on the interior of the stalk between the joints, high up, without causing a swelling. It undergoes all of its transformations within the stalk, its work causing a premature ripening and greatly reducing the yield.

"Mr. J. G. Barlow, of Cadet, Mo., says in one of his letters to me:

"More than two-thirds of the straws in the field had a larva or pupa in them, and the crop was sadly diminished by them. One farmer had 15 bushels off nine acres; another sowed 15 bushels of wheat and harvested only 30 bushels. My nearest neighbor harvested 6 bushels from ten acres; he could not get a man to cut it for the crop. These are my nearest neighbors. Many did not get their seed back."

The above statement in reference to this insect was published by us in the *Rural New Yorker* for March 4, 1882.

In the meanwhile Prof. G. H. French had been studying a Wheat stalk-worm in Illinois, and we quote from his communications to us:

The first work of this insect observed by myself was just prior to the harvest of 1880, in the vicinity of Carbondale, Ill. Upon passing a field of wheat my attention was attracted by seeing a great many apparently light heads, some of which were on stalks that were partly dead, though the grain, as a whole, was not quite ripe. Examination showed that many of the heads were only partially filled. The first thought was that Hessian flies had caused the damage, but there were very few signs of either brood of them to be found. Upon cutting open the stalks there were to be seen on the inside one or more small yellowish worms, and as these were in more than half the stalks examined, the conclusion was natural that here was the cause. From the examination made with the pocket lens they were thought to be the larvæ of some Dipterous insect, as they were without feet. A few of the pieces containing worms were taken by myself, but Mr. John Marten, then one of the assistants in the State entomologist's office, and who was with me at the time, took a larger number for examination and rearing, for the purpose of deciding what they were.

As my time was fully occupied with other matters, the portion of stalks taken by me received but little attention, and, as a consequence, they dried up instead of producing the perfect insects. Mr. Marten afterward collected more of the stalks, and after keeping them for a time found a single fly in the jar containing the stalks, evidently hatched from a larva in them when collected. The fly was thought to be a species of *Chlorops*, though what species was not determined, and, indeed, cannot well be now, for the specimen was accidently destroyed, though it might be approximately from the description that was taken when the specimen was first found. No other specimens were obtained. * * * They are to be found on the inside of the culms, usually just above the joints, varying from the joint or internode supporting the head to the second one below this, or in any one of the three upper internodes. The usual place is the second or third one from above; very few in the upper. I do not remember to have found any below the third joint from above. * * * I have noticed this season that in grain infested with Wheat-Stalk Worms the heads were shorter than in fields free from them, as well as not so well filled out at the ends. This would seem to imply a continuous irritation during the whole growth of the worm.

COMPARISONS WITH THE JOINT-WORM AND OTHER ALLIED SPECIES.

During the past winter between twenty and thirty specimens of the adult have been reared. Of these a single specimen only was fully winged, two were furnished with hind wings only, and the rest were wingless, or furnished with mere rudimentary pads. After a careful comparison with the known species of the genus we found that the species was new to science, and published descriptions, under the name of *Isosoma tritici*, in the *American Naturalist* for March, 1882, and in the *Rural New Yorker*, as above quoted.

Tritici differs from *hordei* principally in its smaller size, more slender form, in the smoothness of the head and thorax, in being hairy, and in possessing the large pronotal spot. In this latter respect *tritici* proves a marked exception to the rule laid down by Walker, (Notes on Chalcididæ, p. 7), that this spot, though present in the European species, is absent in all American and Australian members of the genus. This rule, however, must have been laid down upon very insufficient grounds, as even in *hordei* this pronotal spot is as evident as upon the European

I. verticillata Walker, of which we have received many specimens from Walker himself.

Considerable confusion respecting this wheat insect has arisen during the past year from the fact that Professor French, in the *Canadian Entomologist*, and also in the *Prairie Farmer*, described the work of what is evidently this species in the wheat-fields of Illinois, and published a technical description of the adult, under the name of *Isosoma allynii*. From this description, and from specimens which Professor French forwarded at our request later, it was evident that this species did not belong to *Isosoma* at all, but to the well-known genus *Eupelmus*, and, as the latter genus is, so far as known, always parasitic, it became at once evident that Professor French had mistaken a parasite of the *Isosoma*, or of some other wheat insect, for the true author of the damage. One reason for this mistake can probably be traced from the following facts: Before the adult *Isosoma tritici* had been bred there was some discussion between Professor Thomas and ourself as to whether the larvæ in the stalks were really Hymenopterous or Dipterous. We insisted that they were Hymenopterous, and that a *Chlorops*, which he had bred from wheat and published as the true author of the damage, had come from some other larva. Upon breeding the *Isosoma*, in the spring of 1881, we wrote Professor Thomas we had done so, in support of the correctness of our supposition. It was probably this fact that led Professor French to consider the insect which he bred an *Isosoma*.

At the same time another species, found on a wild grass (*Elymus canadensis*), was described by Professor French as *Isosoma elymi*. This species proved to be a true *Isosoma*, and it was thought by Professor French that it might be identical with *tritici;* but a comparison of a specimen which he sent us with types of *tritici* showed several marked points of difference; so that this question, referred to by Professor French in an article in the *Prairie Farmer* of March 11, 1882, may be considered as settled.

It is worthy of remark that *I. tritici* seems to be quite closely related to the European *Isosoma lineare*. This latter species was bred from wheat by Dr. Giraud, who considered it as an inquiline, or a parasite upon *Ochthiphila polystigma* Meigen—a Dipterous insect making swellings in the stalks. Kaltenbach, however, remarks that although he many times obtained the Isosoma from the wheat, he never succeeded in rearing the Ochthiphila—a suggestive fact, and which would seem to indicate that the *I. lineare*, like our species, is the real author of damage to the wheat.

NUMBER OF BROODS.

From the facts gathered in relation to *I. tritici* it seems most probable that there is but a single annual generation, and, as already stated, that it hibernates normally in the larva and pupa states in the wheat stubble and straw, the adult insects appearing in March and April.

REMEDIES.

With this state of affairs the remedy is obvious, namely, the burning of the stubble after harvest. As plowing under seems never to have proved particularly efficacious with the Joint-worm, we have no reason to suppose that it will be more so with this insect. Inasmuch as wheat-fields after harvest are often allowed to grow up with weeds, Professor French suggests that a mowing-machine be run through the weeds, and that after they have dried sufficiently, the burning of the stubble can thus be made more thorough. Certain observations made by Professor

French the present summer would seem also to show that rotation of crops will prove a good preventive. A critical examination of three fields, two of which were last year also in wheat, while the third was in clover, showed that in the former case 93 per cent. of the stalks contained from one to three worms each, while in the latter not more than 5 per cent. of the stalks were infested.

PARASITES.

Although we cannot yet say with certainty that *Eupelmus allynii* is parasitic upon our wheat Isosoma, yet, considering the circumstances under which it was obtained, this seems probable. We have bred, however, a true parasite from the specimens received from Tennessee, which, according to Mr. Howard, belongs to Förster's genus Stictonotus. It may be described as follows:

STICTONOTUS ISOSOMATIS, n. sp.—*Female.* Length of body 3.25^{mm}; expanse of wings 4^{mm}; greatest width of fore wing .85^{mm}. Antennæ sub-clavate, finely pilose. Head and face finely punctured; pro-and meso-thorax rather more closely punctured; abdomen very delicately shagreened. General color metallic green; antennæ black, club brownish; front coxæ and femora metallic green; distal end of femora, all of tibiæ and tarsi except tarsal claw, honey-yellow; middle coxæ metallic green; femora black, yellowish at either end; tibiæ honey-yellow with a longitudinal dorsal streak, tarsi honey-yellow except last joint; hind coxæ, femora, and tibiæ shining black, with distal end of femora and either end of tibiæ honey-yellow; tarsi honey-yellow except last joint, which is black; wing veins honey-yellow. Entire body sparsely covered with short delicate white hairs.

The ♂ has more markedly clavate antennæ and is nearly free from the whitish hairs, except at tip of meso-scutellum and at tip of abdomen.

Described from 1 ♀, 2 ♂s, bred from *Isosoma tritici* Riley.

DESCRIPTIVE.

We append the original description of the adult from the *American Naturalist*, together with a description of the larva:

ISOSOMA TRITICI. N. sp. *Female.*—Length of body, 2.8^{mm}; expanse of wings, 4^{mm}; greatest width of front wing, 0.7^{mm}; antennæ, sub-clavate, three-fourths the length of thorax; whole body (with the exception of metanotum, which is finely punctulate) highly polished and sparsely covered with long hairs toward end of abdomen; abdomen longer than the thorax, and stouter. Color, pitchy-black; scape of antennæ, occasionally a small patch on the cheek, mesoscutum, femoro-tibial articulations, coxæ above and tarsi (except last joint) tawny; pronotal spot large, oval, and pale yellowish in color; wing veins dusky yellow and extending to beyond middle of wing; submarginal three times as long as marginal; post-marginal very slightly shorter than marginal, and stigmal also shorter than marginal.

Described from twenty-four specimens. Of these twenty-four specimens only one was fully winged; two were furnished with hind wings only, and the rest were wingless. Male unknown.

Larva.—Length, 4.5^{mm} (nearly $\frac{1}{5}$ inch); of the shape indicated in Pl. XII, Fig. 3, *a*, *b*. Color, pale yellow; mouth parts brownish. Antennæ appearing as short two-jointed tubercles. Mandibles with two teeth. Venter furnished with a double longitudinal row of stout bristles, a pair to each joint. Each joint bears also, laterally, a short bristle. Stigmata pale, circular; ten pairs, one on each of joints 2 (mesothoracic) to 11.

BIBLIOGRAPHICAL LIST.

RILEY, C. V.—"Worms in Joints of Wheat.—*American Entomologist*, III (1880), p. 181 (July).

[Acknowledges the receipt of Hymenopterous larvæ in wheat from J. K. P. Wallace, Andersonville, Ky., and compares with the common Dipterous wheat flies, figuring *Meromyza americana*.]

THOMAS, CYRUS.—"A new Enemy to Wheat."—*Prairie Farmer*, August 28, 1880.

[Describes briefly the habits of the new Wheat stalk-worm, and gives a detailed description of a species of *Chlorops* (bred from wheat), which he considers the true author of the damage.]

FRENCH, G. H.—"A new Wheat Pest."—*Prairie Farmer*, December 31, 1881.

[Describes "*Isosoma allynii*," subsequently proven to belong to Eupelmus, a parasitic genus, and probably parasitic upon *Isosoma tritici*, the work of which French seems to have seen.]

FRENCH, G. H.—"The Wheat-Stalk Worm."—*Prairie Farmer*, January 28, 1882.

[Correction as to length of larva, and statement that wheat not sown after wheat is comparatively exempt from injury.]

FRENCH, G. H.—"Two new Species of Isosoma."—*Canadian Entomologist*, January, 1882, p. 9.

[Describes *Isosoma allynii* from wheat, and *I. elymi* from *Elymus canadensis*.]

RILEY, C. V.—"The Wheat Isosoma."—*Rural New-Yorker*, March 4, 1882.

[Describes *Isosoma tritici* and gives an account of its habits; calls attention to the fact that French's *I. allynii* belongs to Eupelmus and is parasitic; gives also the differences between *tritici* and *hordei*.]

FRENCH, G. H.—"Entomological Notes."—*Prairie Farmer*, March 11, 1882; *ibid.*, May 27, 1882.

[Corrects his mistake in regard to *I. allynii*, but considers his *I. elymi*, bred originally from the stalks of a wild grass, as the real author of the damage to wheat.]

FRENCH, G. H.—"On some Chalcididæ."—*Canadian Entomologist*, March, 1882, p. 48.

[Substantially the same as the above.]

RILEY, C. V.—"A new Depredator infesting Wheat Stalks."—*American Naturalist*, March, 1882, p. 247.

[Figures larva of *I. tritici*; corrects French's error with regard to *I. allynii*; republishes description of *I. tritici*, and gives an account of habits, comparing with European *I. lineare*.]

FRENCH, G. H.—"The Wheat-straw Worm."—Eleventh Report of the State Entomologist of Illinois, 1881, pp. 73–81. (Published May, 1882.)

[Gives a lengthy account of the damage done by the "Wheat-straw Worm", under the name of *Isosoma allynii*. The descriptions of larvæ and pupæ are evidently those of Eupelmus. An additional proof of this fact is found in his statement that he bred the perfect fly from July 20 on through August, whereas *Isosoma tritici* issues in winter and spring. The article contains many confusing statements, owing to the uncertainty as to whether Isosoma or Eupelmus is referred to in the various portions. In a foot-note at the end of this article he announces his error in calling the Eupelmus an Isosoma, and states *Isosoma elymi* to be the author of the damage.]

FRENCH, G. H.—"Notes on Isosoma Elymi."—*Canadian Entomologist*, May, 1882, p. 97.

[Shows that *I. elymi* is distinct from *I. tritici* Riley.]

THE SORGHUM WEB WORM.

(*Nola sorghiella*, new species.)

Order LEPIDOPTERA; family BOMBYCIDÆ.

[Plate XI, Fig. 1.]

ITS INJURIES.

During the past summer the heads of sorghum in Southern Alabama were found to be infested with a new Web worm. Specimens were sent to the Department in July by J. P. Stelle, of Citronelle, Mobile County, Alabama. The letter accompanying them is well worth quoting:

For several years the people of Kansas have been deeply interested in a variety of *Sorghum vulgare*, which they call rice corn or pampas rice. They claim that it succeeds better on dry and poor land than any grain known. We of the lower South have been putting it to the test, with much encouragement. I have grown it for three years, and have found it wonderfully productive (yielding two crops each season), and highly valuable as a fodder for cattle and a grain for fowls. By to-day's mail I send you a head of the plant, a fair sample of ten acres now under culture, which seems to demonstrate that its fate is sealed, for this locality at least. I never before saw an insect of any kind working upon it. I find that the patches belonging to my neighbors are all in the same condition; it is literally a clean sweep. I am saving seed by clearing a few heads of the worms and binding gauze cloth over them. The sudden appearance of the present immense brood of the caterpillars was the first indication I had of their presence. They confine their operations entirely to the head and grain of the plant, totally destroying the grain while in the milk.

HABITS.

The specimens sent by Mr. Stelle were carefully studied and reared to the adult stage. The sorghum heads sent were, for the most part, so interwoven with silk as to form a compact mass, in which was profusely mixed the whitish excrement of the larvæ. Running through this mass were numerous delicate tubes, forming channels, through which the larvæ passed from one seed to another unexposed to the attacks of parasites. The kernels of grain were sometimes entirely eaten, but in general were only partly destroyed, the germ, however, seeming to be the portion of the seed preferred, as in almost every instance it was eaten. The larvæ were very active when disturbed, and left the heads when ready to transform, spinning small silken cocoons upon the surface of the ground or in some sheltered place. The cocoons were about 7^{mm} (a little more than a quarter of an inch) in length, somewhat thickest at the anterior end, and with a small opening at the posterior end, through which the last larval skin was partially pushed. They were made of delicate, closely-spun white silk, firmly fastened to the object selected by the larva for attachment, and were covered with particles of wood, bark, or excrements, so that they were readily recognized.

The moths issued in late July or early August, a week or more after the spinning of the cocoons.

SYSTEMATIC POSITION.

The species seems to belong to the rather composite genus *Nola* of Leach, in the same group with Zeller's *nigrofasciata*. The *malana* of Fitch and *zelleri* of Grote are now placed by Grote under *Nolophana* in the Noctuidæ. The species under consideration possesses the peculiar scale tufts of the Nolas described by Zeller, and agrees in the venation of the front wing with the *N. confusalis*, H. S., given by Zeller in his *Beiträge*, differing only in the lack of vein 5 in the hind wing.

The species seems to be new. Lord Walsingham, in a private letter, states that it comes near the *Nola innocua*, described by Butler, from Formosa, and that it is also closely related to a species figured by Snellen von Vollenhoven.

DESCRIPTIVE.

NOLA SORGHIELLA, n. sp.—*Imago* (Pl. XI, Fig. 1 *g, h*).—Average expanse 9.3^{mm} Head and thorax heavily scaled. Color silvery-white; the front wings with three equidistant tufts near costa, the basal less distinct than the others, the distal one at about outer third of wing; the tufts, an arcuate shade towards posterior border, and a spot just within the disk, yellowish-brown; the costa (except pale costal mark) and a shade along posterior border, broadening anally, of a deeper brown, and often mixed with a few deep brown or black scales. Scales loose and markings easily effaced. Antennæ in ♂ finely pectinate and very sparsely scaled. Palpi in ♂ longer, but with shorter, less dense scales than in ♀. Trophi pale yellowish. Legs in both sexes, and more bushy palpi of ♀ marked with pale yellowish-brown.

Described from seven specimens bred from *Sorghum vulgare* var., and two specimens captured in Florida in 1881 by Mr. A. Koebele.

Larva (Fig. 1 *c*, *d*).—Length when full grown 13mm. General color either yellowish or light greenish-yellow, with two quite broad brownish dorsal stripes, and sometimes narrow subdorsal and lateral lines of same color, dorsal line almost sulphur-yellow. Head yellow, small, and retractile. Stigmata small, brownish, situated anteriorly at base of piliferous warts. Each segment with a transverse dorsal row of six prominent piliferous warts of the color of the body, and a somewhat smaller similar wart at base of legs, all furnished with short, stiff, and very sharp yellowish bristles with brownish tips; those of the lateral warts are intermixed with a few long and slender hairs. Legs yellowish.

Pupa (Fig. 1 *e*).—Length between 5 and 6mm. Color brownish-yellow, darkest on dorsum and abdomen. Of almost equal thickness throughout; abdomen beyond the wing-cases somewhat curved towards the venter. Head rounded. The two posterior legs extending beyond wing-cases almost to posterior margin of fifth abdominal segment. Posterior margin of segments 4–6 prominent and rounded. Last segment small, rounded, with a small longitudinal dark brown ventral impression and without any spines around tip. Stigmata small, not very prominent, placed in a somewhat oblique direction. The whole surface closely covered with minute brownish granules.

THE CATALPA SPHINX.

(*Sphinx catalpæ* Boisd.)

Order LEPIDOPTERA; family SPHINGIDÆ.

[Plate XIII.]

There has existed great difference of opinion as to the value of the Catalpa, whether as a shade or timber tree, a difference to some extent due to the confounding of two distinct forms. During the past year (1881) Dr. John A. Warder, the veteran horticulturist, now president of the American Forestry Association and senior vice-president of the American Agricultural Association, published a paper in the journal of the latter association on the Western Catalpa tree, *Catalpa speciosa*, wherein he gave a historical account of the introduction of that and its Eastern relative, *Catalpa bignonioides*, into the several parts of the United States where those trees now grow, and distinguished the two species by description, setting forth the superiority of these trees to most others for their durability and the especially excellent qualities of the Western form, which, at first characterized by Dr. Warder as a variety only of *bignoniodes*, has now been accepted as a species and fully described by Dr. Engelmann.

Herein Dr. Warder refers to the almost complete exemption of these trees from the attacks of insects, noting, however, that they are frequently defoliated by one species, the *Sphinx catalpæ* of Boisduval, the larva of which he describes as greenish, a description that is misleading.

PAST HISTORY OF THE SPECIES.

Owing to the interest lately manifested in the Catalpa, we have thought it meet to give an account of the insect which is its chief enemy, especially as the species has an exceptional interest for the entomologist: first, because it departs from the typical characteristics of its family in laying its eggs *en masse*, and in the larvæ being at first gregarious and of unusually bright color; secondly, because the moth is so rare and little known that it is neither included in Grote and Robinson's List*

* List of the Lepidoptera of N. A., Phila., 1868.

nor in that issued by the Brooklyn Entomological Society during the past year.

This species was first described from Georgia, where it is quite common. Abbot mentions the fact that the fishermen who inhabit the borders of the swamps hunt for it as the best bait for catching fish,* and it is so esteemed for this purpose in Florida that the Catalpa is often cultivated for no other purpose than to attract the insect, and thus afford bait easily accessible. It occurs throughout the native habitats of the Catalpa trees in the western and southern United States, *i. e.*, to quote from Warder, from the Gulf of Mexico in West Florida and on the rivers in Alabama and Georgia, westward and northward along the Mississippi and its southern tributaries in the great delta formation, to above the mouth of the Ohio, thence up the Wabash and White Rivers of Indiana to its most northerly point hitherto known, near Vincennes, in latitude 38° 42′. It doubtless also occurs along the Tennessee and the Cumberland Rivers, having been seen near the embouchures of those streams into the Ohio.

We first received this insect in the summer of 1875, from Mr. Lewis B. Parsons, of Flora, Clay County, Illinois, who sent the larvæ, inquiring as to the species, &c. The following year he wrote:

FLORA, CLAY COUNTY, ILLINOIS, *June* 14, 1876.

DEAR SIR: The worms of which I wrote you last year are again troubling my Catalpa trees. Can you not suggest to me something which may be effectual in destroying them, by throwing some preparation over the leaves or in any other way? All the Catalpas in this neighborhood are infested in the same way.

Your early reply will much oblige,

Very respectfully,

LEWIS B. PARSONS.

Prof. C. V. RILEY, *State Entomologist.*

We wrote recommending syringing the trees with Paris-green water, and somewhat later received from him the following experience:

JUNE 17, 1876.

Thanks for your postal card. Before I had a chance to try your prescription of Paris green I heard of lime-water and tried it. Once syringing the trees so effectually drove them off I have not yet been able to find any worms to send you. If they appear again I will send you as you desire.

Yours, truly,

LEWIS B. PARSONS.

In September, 1878, we received the larva again from Mr. John Robinson, of Goldsborough, Wayne County, North Carolina, with an account of its injury there.

Finally, the following year, Dr. Warder wrote:

NORTH BEND, OHIO, *January* 20, 1879.

DEAR SIR: There is in Southern Illinois a large, naked, greenish caterpillar which feeds in great numbers on the foliage of the Catalpa, often stripping the trees; in Alabama it is six inches long. What is it?

I will send you some pupæ of a small insect found in the seed-pods of the same tree, to be identified.†

From your friend

WARDER.

Prof. C. V. RILEY.

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*Boisd. Spec. gen. lép. het., 1874, vol. 1, p. 104.

†A small Muscid, of which we hope soon to publish an account.

On October 9 of the same year we received numerous specimens of the larva, of all sizes, from Mr. A. E. Ebert, of Knoxville, Tenn., with an account of the injury there. All the specimens were badly parasitized by *Apanteles congregatus* (Say), a small ichneumonid of the Microgaster group, which infests many other Sphingid larvæ.*

CHARACTERS AND NATURAL HISTORY.

Since then we have frequently met with the work of this species in our travels in the South, and in 1880 had the good fortune to obtain the eggs at Atlanta, Ga., where the insect often totally strips the Catalpas that are commonly grown in the city as shade trees.

The eggs are laid in convex masses, a habit belonging, so far as we now know, to no other species of the family. One mass in our possession contains nearly 1,000 eggs, and this betokens a prolificacy unparalleled in the family, and, we may say, very exceptional in the whole order Lepidoptera. Each egg is about 1.2^{mm} long, broadly ovoid, being slightly broader anteriorly than posteriorly, the shell being delicate and smooth, and the color pale yellowish-green. The eggs are but slightly held together irregularly, and the mass but slightly fastened to the underside of a leaf. They must, also, according to the observations of Mr. Albert Koebele, who has reared the species in Florida, and has, under the name of *Daremma catalpæ*, published a description of the egg and larva,† be laid at times in smaller masses on the stems and branches.

The newly-hatched larvæ are pale-yellowish, with a rather stout caudal black horn. They are gregarious, feeding side by side, and they have a curious habit of following one another in procession when moving from leaf to leaf or from branch to branch. The gregarious habit endures more or less till they are nearly grown. There are, judging from the different larvæ in our cabinet, four molts, the immaculate color giving way after the first molt to the series of black spots shown in the smaller larvæ in our figure.

While the younger larvæ are always pale-yellowish (sometimes nearly white) and spotted, there are very great variations in the markings of the older specimens. A few of these variations are indicated in our illustration, but the darker form there figured predominates.

The pupa is slender, reddish-brown, about 35^{mm} long and 8^{mm} broad, finely punctate, with an acute, rather long, terminal spine, very slightly notched at tip. There is, on each side, a long, transverse, open slit on the anterior margin of abdominal joints 5, 6, and 7, the lower end nearly in line with the lower end of the spiracles.

The general color of the moth is grayish-brown or ashy, marked as in the figure. The front wings are crossed by two indistinct blackish lines or shades beyond the middle, and by three such shades between the middle and the base, these shades sometimes obsolete. There is a small spot, of the ground color or lighter, near the middle of the wing, surrounded by black, and a patch lighter than the rest of the wing at the tip, bounded below by an oblique, wavy, black line. The hind wings are smoky brown, crossed by two blackish bands, which meet at the inner angle. The fringes of the wings are alternately cinereous and whitish on the outer margin, whitish on the inner margin. The wings beneath are ashy and smoky brown, shaded, and show traces of

*See "Notes on N. A. Microgasters." Trans. Acad. Sci., St. Louis, 1881. Separate ed., p. 14.

†Bulletin, Brooklyn Ent. Soc., 1881, v. 4, p. 20.

the bands of the upper surface. Thorax whitish on lower part of sides, ashy on top, darker on upper part of sides, with a black line running through the latter portion. Abdomen ashy, with a central black line on top, and with a subdorsal and traces of a lateral band of black spots on each side.

In the extreme South the insect may be found in all stages during the summer, there being three or four broods, and the last brood hibernating in the pupa state beneath the ground, and giving forth the moth the following March. The time required in summer from the laying of the egg to the emergence of the moth averages, according to Mr. Koebele, about six weeks.

REMEDIES.

The worms thoroughly denude the trees as they spread from the hatching center, and it is because of their gregarious nature and the great fecundity of the species that the injury it causes is often so great, though generally restricted to one or more trees in a row.

In addition to the parasite already mentioned, which often sweeps off whole broods, the worms are attacked by various birds. It is fortunate, in fact, that the species is so persistently followed by natural enemies, for were it otherwise the Catalpa could hardly be grown without persistent effort on man's part to protect it. That the tree may be easily protected would appear from Mr. Parsons' experience with lime-water, while we have no doubt that a spraying of London purple or Paris-green water would prove still moreeffectual. The gregarious habit, also, is a great inducement to vigilance on the part of those who suffer from the depredations of the worms, as they may easily be detected when young and destroyed in a body before they have scattered over the whole tree or spread to adjoining ones.

As Boisduval's figures are not from life, and are in fact rather poor, we shall indicate the chief characteristics of the species for the entomological reader:

DESCRIPTIVE.

SPHINX CATALPÆ.—*Egg*, 1.2^{mm} long; elliptical, slightly wider and more obtuse at anterior than at posterior end, usually very slightly flattened; smooth; pale yellowish-greenish; white and iridescent after the escape of the larva.

Larva.—The *newly-hatched larva* is about 3^{mm} long, of a pale-yellowish color, the ocelli and caudal horn alone being dark. This last is stout, slightly tuberculate, and about half the length of the larva, ending bluntly with two stiff, diverging hairs. The head is smooth and polished, and the whole body is sparsely covered with minute colorless hairs. In the *second stage* the head remains smooth and polished, and usually becomes dark, and there are three (a medio dorsal and a subdorsal) series of black, subquadrate patches. The eight wrinkles to each joint are perceptible, but the hairs are mostly lost, and give way to a transverse series of very minute papillæ. In the *third stage* the black slightly increases by the elongation of the patches and their partial connection on the subdorsal line. The head and cervical shield are now covered with papillose points, and the papillæ on the general surface of the body are proportionally more reduced. In the *fourth stage* the head and the whole surface of the body become smoother and more velvety, the minute papillæ of the previous stage being lost, except on the head and cervical shield. The black series of spots generally coalesces on the back, so as to form a broad, black dorsal surface, with a narrow pale line near either border. A substigmatal line of black and an irregular supra-stigmatal series of spots or dashes usually obtain. In the *fifth stage* the head and cervical shield also become smoother.

The above description, so far as color is concerned, applies to the more common and darker form. In the paler larvæ the head and legs retain their pale color till maturity.

Chrysalis.—Shiny, reddish-brown, unicolorous, slender, cylindrico-conic, about 35^{mm} long; the thorax slightly broader than the abdomen, which latter tapers acutely behind. (In the only pupa-skin at hand the portion which covered the head and limbs is broken away, except that over the hind wings and hind edge of the front wings.)

The whole surface, except on the abdominal joints 4-6, shallowly punctate, the punctations becoming denser anteriorly above until the thorax appears rugose. Terminal spine slender, subconical, acute, 1^{mm} long, its tip very slightly notched. Region anterior to the spine beneath evenly rounded, with a short longitudinal median sulcus. A transverse open pocket or elongate concavity on the anterior margin of abdominal joints 5, 6, and 7, three to four times as long as the spiracular openings, with its lower end in line with the lower end of the spiracle on joints 5 and 6, and slightly higher on joint 7; edges of the slits black. The ends of this slit are rounded and the entire edge is dark and sharply produced. On the inside the pupa shell shows this pocket to be entirely closed and rigid, resembling, in fact, an elongate, egg-like swelling.*

Imago.—The moth, already described and here figured, differs from the figures given by Boisduval so markedly that identification by his figures alone would be difficult or impossible. It has no greenish tinge whatever, the apical oblique line is very differently curved, and the apical patches differently shaped, not at all yellow; the transverse lines are far less distinct and are differently curved; and the bands on the hind wings converge toward the inner angle.

THE OSAGE ORANGE SPHINX.

(*Sphinx hageni* Grote.)

Order Lepidoptera; family Sphingidæ.

[Plate XII; Fig 2.]

The value of the Osage orange as a hedge-plant, of its bright yellow wood as a durable timber, and particularly the value of its leaves as silkworm food, give interest and importance to the consideration of any insects that affect it injuriously. The plant is remarkably free from such injurious species, and, with the exception of the Lightning Tree-hopper (*Pœciloptera pruinosa*), which is known to do serious injury to hedges in in Southern Illinois, a longicorn beetle (*Dorcaschema alternatum*), which bores into the root and stem, and an undetermined Pyralid, we know of no other insect that can be called injurious beyond that under consideration.

This Sphinx is sufficiently rare in most parts of the country not to be recorded in Grote and Robinson's List of Lepidoptera of North America, already referred to (p. 189, *ante*); yet the late Jacob Boll, of Dallas, Tex., from whom most of the specimens in collections have been derived, informed us that the larva is sufficiently common in that part of Texas to sometimes defoliate special trees. It is because of this fact, and the further fact that no good published account exists, that we have had the accompanying figures made, and have drawn up this short account.

The species was originally described by Grote,† who referred it to the genus *Ceratomia*, a genus founded by Harris for a species (*Ceratomia quadricornis*‡), which feeds on the Elm, and the larva of which is characterized by four short horns placed quadrilaterally on the second and third thoracic joints.

*This elongate concavity is a peculiar structure, not mentioned by Westwood, Burmeister, Kirby & Spence, Girard, Clemens, Harris, Graber, or any modern author whom we have been able to consult. There is an approach to it in the pupa of *Ceratomia amyntor*, and it occurs in that of *Sphinx harrisii*, in similar position and form as in *catalpæ*. In *Macrosila 5-maculata* it is somewhat above the spiracles, and that on the fifth abdominal joint has a second larger ridge running around it posteriorly. It does not occur in any of the species of the genera Sesia, Thyreus, Darapsa, Deilephila, Philampelus, and Smerinthus in our collection. It has no internal connection with the respiratory or circulatory systems, and its function is probably sound-producing by friction with the posterior margin of the preceding joint. This organ may, in fact, throw some light on the method by which the noise is produced which the pupa of *Sphinx atropos* is known to be capable of. Unfortunately, we have no pupæ of that species for examination.

†Bull. Buffalo Soc. Nat. Sci., 1874, v. 2, p. 149.

‡*Agrius amyntor* Hübn.

CHARACTERS OF THE SPECIES.

We have never seen the egg. The prevailing color of the larva is pale apple-green, inclining more or less to yellowish-green, the caudal horn being carneous, the thoracic legs rose-red, and the venter somewhat reddish.

The moth is one of the most beautiful of the Sphinges, the general color being light brown, with olivaceous shades, and marked with black and white, as indicated in the figure. There is a small white spot, surrounded by black, near the middle of the front wings, and a large white patch immediately outside of this, as well as another at the tip of the wing, the latter bounded behind by an oblique, wavy, black line. The wing is crossed by four transverse black lines outside of the central spot, one of which runs into that spot, and two or three nearer the base. The outer margin is strongly shaded with white, and the fringes alternately of the ground color and white. The hind wings are smoky brown, lighter toward the base, crossed by an indistinct darker band. The under side of the wings is cinereous, crossed by darker lines. The middle of the thorax is of the color of the fore wings, the edges whitish, with a black line running through the white portion. Abdomen brownish cinereous, with dorsal, subdorsal, and traces of lateral black lines, as shown in our figure. The variation is great, some specimens being very light, others almost black.

AFFINITIES.

This insect somewhat resembles, both in the larva and imago state, *Sphinx* (*Daremma*) *undulosa* of Walker, which we have bred from Ash. This last is, however, larger, and never has any olive-green coloring on the wings. *Hageni* still more closely resembles, in markings of the front wings, the *Sphinx lugens* of Walker, which feeds in the Western States on the wild sage (*Salvia trichostemmoides*); this species has two broods, and hibernates in the chrysalis state, and it is more than likely that *hageni* will agree with it in these respects.

We do not know why Mr. Grote referred this species to *Ceratomia*, nor is it easy to understand upon what good and permanent classificatory characters in the imago the genera *Ceratomia*, *Daremma*, and *Macrosila* are founded. We consider that *hageni* is congeneric with *lugens*, which by all systematists is placed in the genus *Sphinx*.

Besides the original description of the species, mention of it may be found in the Transactions of the Zoological Society of London, for 1877, vol. 9, p. 621, by A. G. Butler; and in H. Strecker's Lepidoptera, Rhopaloceres et Heteroceres, 1877, No. 14, p. 127, Plate 14, Fig. 6.

DESCRIPTIVE.

SPHINX HAGENI.—*Larva.*—Average length when full grown, 55^{mm}; head triangular, flat in front, three-fourths as wide as high; apex slightly bifid; abdominal joints cylindrical; thoracic joints tapering forwards to the head, covered with pale granulations, thickest on the sides of the head, on the thorax, and the caudal horn and anal plate. There is a series of these papillæ on each of the eight transverse wrinkles of each joint, taking the form of two pretty regular medio-dorsal lines on joints 6 to 10, and largest on the ordinary oblique pale stripes, which are normal, and broadest and most distinct posteriorly. Caudal horn of medium length, stout, carneous. Head and body uniformly green; mandibles and eye-spots black; a yellowish-white stripe on each side of the head, running from the inner edge of the eye-spot to the tubercle on the crown. The oblique lines are yellowish-green, and apparently in the living specimen a superior shade of rose may have accompanied those on the middle joints. Each spiracle on joints 4 to 11 is white, and is placed in an irregular, reddish-brown spot.

Described from a blown specimen received from Mr. Jacob Boll.

REPORT ON MISCELLANEOUS INSECTS.

By Prof. J. Henry Comstock, *of Cornell University, Ithaca, N. Y.*

THE APPLE MAGGOT.

(*Trypeta pomonella* Walsh.)

Order Diptera; family Trypetidæ.

[Plate XIV.]

Eating into the pulp of apples and causing them to decay; a white cylindrical maggot, which when full grown goes into the ground to transform. The adult is a black and white fly, with banded wings.

Without doubt the most important insect enemy of the apple is the Codlin-moth or Apple-worm, as it is often called. This is the small white or pinkish caterpillar which infests apples near the core, and in leaving the apple makes an ugly burrow through its side. The importance of this pest is due to two facts: first, it is very widely distributed, occurring almost everywhere that apples are cultivated; second, it is usually so abundant wherever it occurs that it destroys a large proportion of the fruit.

There is another enemy of the apple which, in certain localities, rivals the Codlin-moth in the extent of the injury it does. I refer to the insect known as the Apple Maggot, and which is becoming quite common in certain parts of New York and New England. This insect was described nearly fifteen years ago* by Mr. Walsh, under the name of *Trypeta pomonella*. But the report in which this description occurs is now out of print, and almost unknown in the localities in which the Apple Maggot has attracted attention, except to entomologists. I will, therefore, give the results of the studies which I have made of this insect during the past two years.

The Apple Maggot is a small white footless larva, measuring from 5^{mm} to 7^{mm} (.19 to .27 inch) in length. In some instances the body is yellowish-white; in others it has a greenish tinge. The important peculiarity in the habits of this insect is that it bores tunnels in all directions through the pulp of the fruit; frequently these tunnels enlarge into cavities the size of a pea; and when several larvæ are present in the same apple it is honeycombed so as to be rendered useless.

It will be seen at once that the injury done by this pest is even more serious than that done by the Codlin-moth. For as the injury caused by the latter insect is confined to the neighborhood of the core and to a single, nearly straight, and conspicuous tunnel which the larva makes when leaving the apple, it often happens that the injured parts of an apple may be cut away and the remainder eaten. But the nature of the injury caused by the Apple Maggot is such that when fruit becomes infested by this insect no one cares to attempt to use it.

The Apple Maggot is a native American insect, which naturally feeds on the different species of hawthorn (*Cratægus*) and upon crab-apples. It is probable that this insect occurs throughout the country wherever hawthorns or crab-apples are found. Mr. Walsh observed it long ago

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* American Journal of Horticulture, Dec., 1867; also, Report Acting State Entomologist, Ill., 1868, p. 29.

as far west as Illinois, and I have bred the adult insect from a species of Cratægus growing on the Agricultural Grounds at Washington.

In certain parts of New York and New England the species has acquired the habit of feeding upon the cultivated apple. But, what is very remarkable, it does not appear to have done so in other parts of the country. Thus, although Mr. Walsh bred this insect from haws in Illinois twenty years ago, I can find no record of its infesting apples in that State yet. And in Washington it infests haws growing near an orchard in which it has not been observed.

In those localities in which this insect has spread to the cultivated apples and become common it is even a more serious pest than the Codlin-moth, except that it seems to be more fastidious in its choice of food than that insect. Thus, although I have observed it for several seasons in one of the orchards of Cornell University, I have found it only in a few varieties of fruit. This may account for the slowness of the spreading of the species from haws and crab-apples to the cultivated apple, and may afford a means of reducing to a minimum the injuries of this pest.

In certain parts of New Hampshire the Apple Maggot is known as the "Railroad Worm". The extent of the ravages of this insect in certain parts of that State is indicated by the following extract from a letter which I have received from Mr. N. W. Hardy, of the town of Nelson:

> In regard to the Railroad Worm, I never saw one in this town. In the last six years they have worked in the adjoining towns of Hancock and Dublin. They are confined to early apples as soon as they ripen.
>
> I saw a man the other day that said that this insect had ruined his apples so that he would have to graft them into winter apples.
>
> Many of the early varieties of apples in Hancock and Dublin were rendered entirely worthless. We have more to fear from this insect than any other that preys upon the apple.

Mr. Isaac Hicks, of Long Island, who was one of the first to observe this insect in apples, many years ago, does not consider it so serious a pest as does the correspondent just quoted. The following extract from a letter recently received from him is interesting as bearing on this point, and as suggesting remedial measures:

> Thine of 17th received; and, in reply, will give thee what little I know of the Apple Maggot, *Trypeta pomonella*. Its ravages bear no comparison to the injury done by the Codlin-moth to fruit. Last year being the non-bearing season, we saw very few apples, if any, infested with it. It is different from the Codlin-moth, which can place its egg in the very young fruit, go through its transformations, and lay its eggs in winter apples. We seldom see the Trypeta until about the 1st of September, and never in green fruit. Only in the ripest apples and in sweet or mellow subacid fruit are they found by us. I think they cannot exist to much extent if pigs or sheep run in the orchard, as they prefer the ripe apples, in which alone the Apple Maggots can develop and attain their growth. Hence, where the fruit that falls is picked up frequently and sent to mill to be ground, or where pigs and stock or the family consume it freely, very few of the Maggots arrive to perfection.

It is evident, from my observations and from those of my correspondents, that the Apple Maggot is much more apt to infest early apples than the winter varieties. But the latter are not exempt from its attacks. Mr. Henry Thacker, of the Oneida Community, New York, writes me as follows:

> This worm at this place, and at this time, is mostly confined to certain varieties of autumn apples. But at Wallingford, Conn., the winter apples were ravaged as well. Of late years, however, the Baldwin and some other varieties of winter apples growing here have been found bored by this maggot.

I will now give an account of each of the stages of this insect, which are represented on Plate XIV, excepting the egg, which has not yet been observed.

Larva.—According to my observations and all published accounts, the Apple Maggot does not occur in the apple till the latter part of the summer. As already stated, it is a footless larva about one-fourth inch in length and white in color, with sometimes a yellowish or greenish tinge. Several figures illustrating its form and structure are given on Plate XIV. Figure 1 represents its general appearance when greatly magnified. The caudal two-thirds of the body is cylindrical; the cephalic one-third tapers slightly to the head, which is the smallest segment of the body. On the dorsal surface of the body there is on each side, at the union of the first and second segments, a pale-brown tubercle. These are the cephalic spiracles. The structure of these spiracles is quite complicated. (See Plate XIV, Figs. 1*a* and 1*b*.) Each one is expanded into a plate, the free margin of which is fringed by a double series of cylindrical projections, about twenty in number. With a very high power of the microscope the distal end of each of these projections appears to be sieve-like; an arrangement which doubtless prevents the entrance of any foreign matter into the respiratory system. With a low magnifying power the main tracheæ connected with these spiracles may be seen. These are represented in Fig. 1, a single large trunk on each side extending the whole length of the body. These are connected near each end of the body by a large transverse trunk. Many of the smaller tracheæ which branch from the main tracheæ are usually visible, but they are not represented in the figure. The caudal end of each of the two main tracheæ opens by means of a very complicated spiracle. These differ much in structure from the cephalic spiracles, and are situated on the last segment of the body. One of them, the right, is represented at Fig. 1*c*. There are three transverse slit-like openings, which are fringed by a series of teeth, which are apparently chitinous. The function of these teeth is doubtless the same as that of the sieve-like membrane closing the ends of the tubular projections of the cephalic spiracles. Each of the caudal spiracles is accompanied by four groups of bristles, two upon the lateral side and one each upon the cephalic and caudal sides.

The caudal end of the body is obliquely truncate, the ventral part projecting farther than the dorsal part. This sloping part of the body bears four pairs of tubercles. One pair of these is more prominent than the others.

The mouth is armed with two black, strong, curved, parallel hooks, which are used in rasping the food. The hooks are connected with an internal, apparently chitinous, framework, which is also black. This is figured from the side in Fig. 1*a* and from above in Fig. 1*b*.

These black oral hooks and the two pairs of spiracles, both of which are brown, are visible to the unaided eye, but their structure can only be made out by the aid of the microscope.

Pupa.—In the autumn when the larvæ are full-grown they leave the apple and enter the ground and transform to pupæ. In my breeding-cages the pupæ were found about one-half inch below the surface of the ground. When the change to pupa occurs the body shortens, but the larval skin is not molted, the transformation occurring within the dried skin of the larva. The pupa (Plate XIV, Fig. 2), therefore, resembles the larva very much, except that it is shorter, of an oval outline, and of a pale yellowish-brown color. Length about 5^{mm} ($\frac{1}{5}$ inch).

Adult.—The insect remains in the pupa state during the entire winter and early summer. Specimens which I bred in Washington began to emerge as adults May 28, and continued to emerge till July 6. But as these were kept in a warm room during the entire winter, their development was doubtless accelerated.

The adult fly is represented greatly enlarged at Fig. 3. The actual length of the body of the male is 5^{mm} ($\frac{1}{5}$ inch); of the female, 6^{mm} ($\frac{1}{4}$ inch). This fly can be easily recognized by the peculiar shape of the black bands on the wings, by the milk-white spot on the caudal part of the thorax (scutellum), and by the white bands on the abdomen. A more detailed description follows:

The *head* is rust-red, with the eyes and the bristles black. The *thorax* is black, with a white stripe on each side, and two silvery stripes on the dorsal aspect; scutellum white except at base. The *abdomen* is black, with transverse silvery stripes above; of these there are in the male three conspicuous ones, making the caudal margins of the second, third, and fourth segments; in the female there are four, which are less conspicuous, and are borne by the first to the fourth segments inclusive. The shape of the abdomen differs also in the two sexes. In the male it is as represented in the figure; the segments successively wider to the fourth. The margins of the first to the fourth segments form two divergent and nearly straight lines. In the female the abdomen suddenly enlarges, so that the second segment is the widest, and the outline of the whole abdomen is elliptical. The *legs* are pale rust-red; the four posterior femora, except at the proximal ends, are brownish black. The *wings* are hyaline, with four black cross-bands; the first, which is near the proximal end of the wing, is confluent with the second near the caudal border of the wing; the second, third, and fourth are confluent near the cephalic margin of the wing and diverge caudad.

Remedies.—The more practicable ways of lessening the injuries caused by this pest are those suggested in the letters quoted above—the destruction of infested fruit promptly after its fall from the tree, and before the maggots leave it to go into the ground to transform; and when the pest is very abundant, the grafting of the trees into varieties less liable to be infested. In such a case it might be well to leave one or two trees of early apples to serve as traps, and promptly destroy the fruit as it falls from them. If such trees could be inclosed, and sheep or pigs pastured under them, the success of the trap would be assured.

The Apple Maggot can be readily distinguished from the larva of the Codlin-moth by the absence of feet and the fact that it infests the pulp rather than the vicinity of the core. But there are other maggots which are associated with this species, and with the larva of the Codlin-moth also, which are not readily distinguished from the true Apple Maggot. These other species pertain to the genus *Drosophila*, and feed upon decaying fruit. They cannot be considered, therefore, under ordinary circumstances, as noxious insects in an orchard. Two species of this genus are described in following articles, under the name of *Pomace Flies*.

THE VINE-LOVING POMACE-FLY.

(*Drosophila ampelophila* Loew.)

Order DIPTERA; family DROSOPHILIDÆ.

[Plate XV.]

A small white maggot, found abundantly in decaying apples, and producing a small, clear-winged, red-eyed fly.

While studying the Apple Maggot (*Trypeta pomonella*) just described I found associated with it two kinds of smaller and more slender maggots, which, so far as my observations go, feed only on the decaying part of the apple, following the Apple Maggot in its work of destruction.

As these maggots are the young of flies which in all stages are very common about the refuse of cider-mills and fermenting vats of grape pomace, I have called them Pomace-Flies. And I have distinguished the two species studied by prefixing to that name in each case a translation of the specific name. Thus, one which bears the technical name *Drosophila ampelophila* may be known as the Vine-Loving Pomace-Fly; and the other, which is *Drosophila amœna*, may be called the Pretty Pomace-Fly. I have preferred the term Pomace-Fly to a translation of the generic name, as being both shorter and more characteristic than "moisture-loving flies".

Although, under ordinary circumstances, the Pomace-Flies feed only on decaying fruit in an orchard, and cannot on this account be considered as pests of the apple, there are cases in which they become quite noxious. They are, therefore, worthy of consideration in this place. Moreover, it is important that the Pomace-Flies should be described in connection with the Apple Maggot, as they are very liable to be mistaken for it; and a mistake of this kind might cause a fruit-grower a great deal of unnecessary trouble.

Mistakes of this kind in regard to these very insects have been made by entomologists of extended experience. I have, therefore, taken much pains to work out the specific characters of the different larvæ.

The Pomace-Flies may be found in any orchard during the autumn, flying about the rotten apples. And their larvæ may usually be seen feeding in great numbers in the decayed fruit. They go through their transformations very rapidly, so that there are several generations in a single season. Numerous observations made by myself and by students in my laboratory* show the following to be the periods of the different stages of the Vine-Loving Pomace-Fly during the month of October. Duration of egg state, three to five days; of larval state, three to five days, usually four; of pupal state, three to five days also; and the time which elapsed between the emerging of the flies and the beginning of laying eggs, in some cases, was not more than two days.

This rapidity of multiplication greatly increases the seriousness of the evil where this insect is a pest. And this is very apt to be the case wherever fruit is ground up or crushed and exposed. Thus they abound about cider-mills, where often it is almost impossible to prevent the flies from ovipositing in the pomace or from falling into the cider. The wine-makers also find them a nuisance about fermenting vats of grape pomace, and about wine faucets in the summer.

But the most serious trait in the habits of this insect is reported by Mr. W. L. Devereau, of Clyde, N. Y. Mr. Devereau writes me as follows:

> The larvæ of this fly completely eat out the inside of grapes which, while hanging on the vines, have first been picked open by birds. The decaying juices running out on the other berries of the cluster spread decay, and thus gave more foothold for the larvæ. Indeed, the larvæ bore from one grape to another, while the imagos are constantly, by eggs, putting in new colonies until the cluster is nearly or quite destroyed, nothing remaining but the empty grape-skins.

Upon Plate XV of this report are represented the various stages of the Vine-Loving Pomace-Fly. The more important characters presented by each are as follows:

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* Careful observations made by Messrs. W. H. Cobb, W. E. Harding, H. Sazé, and John T. Tucker, members of the class in agriculture, have materially aided me in the preparation of this account.

Egg.—Fig. 7 represents the egg, which is elongated in form and white in color. The most striking characteristic of it is a pair of long, slender appendages near the cephalic end. The egg is inserted into the soft pulp of the decaying fruit; these appendages leave the ovipositor last, and are spread out upon the surface of the mass. They in this way serve to keep the egg in place, and thus insure the emergence of the larva into the open air instead of into the more or less fluid mass in which the egg is situated. The larva issues from the egg just above the base of these appendages. The egg, without its appendages, is about .5^{mm} ($\frac{1}{50}$ inch) in length; the appendages are about three-fifths as long as the egg. The whole surface of the egg is facetted with cells, which, although irregular in outline, are usually pentagonal. Projecting from the cephalic end is a small tubercle, the micropyle.

Larva.—The larva is a slender white maggot, which, when full grown, is 4.5^{mm} (nearly $\frac{1}{5}$ inch) in length. The oral hooks and internal skeleton to which they are attached are visible to the unaided eye as a black line. The caudal part of the body usually appears brown; this color is due to the contents of the alimentary canal. The general form of the larva is represented by Fig. 8 of Plate XV. It is widest near the middle, and tapers toward each end, but more towards the cephalic end than towards the caudal. The main tracheal trunks are visible with a low power of the microscope. The general arrangement of them is similar to that of the Apple Maggot. The important character by which this larva may be distinguished from the Apple Maggot and from the larva of the Pretty Pomace-Fly is the structure of the cephalic spiracles. One of these is represented, greatly enlarged, at Fig. 5 of Plate XV. The main trachea divides into several, usually seven or eight, divisions. These divisions all arise from nearly the same point, and each one opens independently. This compound spiracle may be exserted to quite a distance, as shown in Fig. 8, or may be drawn entirely within the mesothoracic segment; whereas it pertains to the prothoracic segment. The two caudal spiracles project backwards prominently. Each one consists of a brown tubercle, in which the tracheæ subdivide, and each division apparently opens separately. There are several semicircular tufts of bristles on each spiracle. These probably prevent the openings from being closed with foreign matters. A side view of this spiracle closely resembles a similar view of the corresponding spiracle of the larvæ of the Pretty Pomace-Fly. (See Plate XVI, Fig. 1*c*.) The caudal segment of the larva we are describing bears five pairs of blunt, rather short, tubercles. These are represented in Fig. 8, Plate XV.

Pupa.—When the larva is full grown it changes to a pupa within or about the apple upon which it has fed, instead of going into the ground, as does the Apple Maggot. Like the Apple Maggot, this Pomace-Fly transforms within the dry skin of the larva. Consequently what we naturally see of the insect in this stage resembles somewhat the larva. It is, however, shorter, measuring only 3^{mm} (.12 inch) in length, but is much thicker. The cephalic spiracles and the tubercles of the caudal end of the body project conspicuously. There is a large concavity on the dorsal surface of the cephalic end. This indicates the point at which the adult fly emerges. On the ventral surface of the cephalic end may be seen the oral hooks of the larva.

Fig. 2, Plate XV, represents the ventral aspect of the puparium, and Fig. 3 is a lateral view.

Adult.—The form of the adult is carefully represented by Fig. 1, Plate XV. The head, thorax, and legs are light-brown, with black bristles and hairs. The abdomen is very pale brownish-yellow; on the dorsal surface the caudal margin of each segment is dark-brown, and in the male the entire dorsal surface of the two caudal segments is of the same color. The male of this species bears a remarkable comb-like appendage upon the first segment of the tarsus of each of the first pair of legs. The venation of the wings is carefully represented in the figure.

Remedies.—Doubtless much can be done to prevent the undue increase of these insects about cider-mills, wine-cellars, and similar places by keeping these places clean, and especially by using care to not leave any decaying fruit exposed. When they infest vineyards, as described by Mr. Devereau, probably nothing will be found practicable except to inclose the clusters of grapes in paper bags, as is already done by many viticulturists to protect the grapes from the grape curculio, birds, and mildew. A few pin-holes should be made in the bottom of the bag, to allow the water to run out, which otherwise in case of a storm would collect and either rot the grapes or burst the bag.

THE PRETTY POMACE-FLY.

(*Drosophila amœna* Loew.)

Order Diptera; family Drosophilidæ.

[Plate XVI.]

A small white maggot, resembling the larva of the Vine-Loving Pomace-Fly, and, like that species, found in decaying apples; but unlike that species in going into the ground to transform, and developing into a red-eyed fly with black spots on its wings.

Associated with the Vine-Loving Pomace-Fly I found another species belonging to the same genus, the *Drosophila amœna* of Loew. For this I propose the popular name of Pretty Pomace-Fly. This species I have not found as abundantly as *D. ampelophila;* but as it is also associated with the Apple Maggot (*Trypeta*), it is liable to be mistaken for that species. I therefore present the following description of the different stages of it:

Egg.—Repeated efforts to find eggs of this species failed, although by imprisoning flies with apples we afterwards found larvæ on the apples, from which we bred adults of this species. Either we overlooked the eggs or the species is viviparous. At least, it is not probable that the eggs are as large and conspicuous as are the eggs of *D. ampelophila.*

Larva.—The larva of the Pretty Pomace-Fly is of the same length as that of the species just described (4.5^{mm}, nearly $\frac{1}{5}$ inch), but it is much more slender. The form of the body is cylindrical, tapering slightly toward the head. (See Plate XVI, Fig. I.) The body is white; the oral hooks and the skeleton to which they are attached show as a black line to the unaided eye. The form of these organs is represented in Fig. 1*a*, Plate XVI. The hooks are not conspicuously toothed, as in *D. ampelophila*, and the framework to which they are attached is more elongated than in that species. The main tracheæ are plainly visible with a low power of the microscope, as with the two species already described; and, as with those species, the most obvious specific character presented by the larva is the form of the first pair of spiracles. These project from the cephalic margin of the first thoracic segment, or may be withdrawn within the segment. Each consists of seven or eight divisions of the trachea, which branch off in a series on each of the two opposite sides. (Plate XVI, Fig. 1*b*.) The two main tracheæ are each terminated by a spiracle at the caudal end of the body. A side view of one of these spiracles is given at Fig. 1*c*. The trachea divides into several branches, each branch opening separately. There are several semicircular tufts of bristles on each spiracle. These probably prevent the openings from being obstructed with dirt. The caudal segment is truncated, and bears eight fleshy tubercles, the two longest of which are situated laterad of the caudal spiracles. Each of these tubercles is tipped with several hairs; only six tubercles are visible from above.

Pupa.—When full grown the larvæ enter the ground to transform, differing in this respect from *D. ampelophila.* My experiments seem to indicate that this species must necessarily go into the ground. From apples thickly infested with the larvæ of both species, but placed in a jar without sand, I was able to breed only *D. ampelophila.* But after the same apples, still containing larvæ of both, were transferred to a jar containing sand the adult forms of both species were reared.

The length of the puparium is 3^{mm} (.12 inch); color brown; the cephalic spiracles project directly cephalad; the caudal spiracles diverge. The puparium of this species may be identified by the structure of the cephalic spiracles described above. For general form of this stage, see Plate XVI, Fig. 2.

Adult.—The adult of this species is represented by Fig. 3 of Plate XVI. As compared with *D. ampelophila*, the body is more slender, the head relatively larger, and the wings are marked with black spots. The flies have the habit of flapping their wings at short and regular intervals. The periods of this species are longer than those of *D. ampelophila*, as it requires a month or more for it to pass through all its stages.

Remedies.—In case the Pretty Pomace-Fly becomes troublesome, the same course of treatment that is recommended for the Vine-Loving Pomace-Fly will serve to keep it in check.

THE OCELLATE LEAF GALL OF RED MAPLE.

(*Sciara ocellaris* O. S.)

Order DIPTERA; family MYCETOPHILIDÆ.

[Plate XVII.]

On the leaves of the red maple (*Acer rubrum*) circular ocellate spots about three-eighths inch in diameter, with disk yellow, and margin and central dot, during one stage of their growth, cherry-red.

The foliage of red maple (*Acer rubrum*) is often seriously injured by certain very small larvæ, which make large and conspicuous spots or galls upon it. This insect is apparently widely distributed. I have observed it both at Washington and at Ithaca, N. Y. At the last-named place it occurs so abundantly that I have repeatedly seen trees every leaf of which was infested.

This insect is so small that of itself it would not readily attract attention, but the result of its work is so conspicuous that it may be seen from a long distance. This appears in the form of a circular spot three-tenths to three-eighths inch in diameter, which at a certain period of its growth is light yellow in color, with a cherry-red margin and central dot. (See Plate XVII, Fig. 1.) At other periods the spot is simply light green or yellow. Frequently these spots occur so thickly as to intersect each other and to completely cover the leaf, fifty or more being on a single leaf. At the center of each spot may be seen, on the upper side of the leaf, an elevated portion. Corresponding to this, on the lower surface of the leaf, there is a pit, within which the larva lives. Larvæ that were partially grown were found to be held in place in the pit in the leaf by what appeared to be a larval skin. This pellicle covers the body entirely, and is with difficulty removed from it; the edges of the pellicle adhere quite tightly to the leaf. When the larva is full grown it forces itself from under this skin, which then falls back into the cavity, or is pushed to one side, where frequently it may be seen adhering to the leaf. The larva at this time drops to the ground, into which it enters to undergo its transformation.

The larvæ are translucent, viscid, nearly colorless. Those in the galls are broad oval (see Plate XVII, Fig. 3); but those which have left them are more elongated, tapering almost equally towards each end. On the lateral margin of each abdominal segment there are one or more short spines, which are directed towards the caudal end of the body. And on the dorsal surface of each abdominal segment, near each lateral margin, there is a small tubular spiracle. There is a distinct head (see Plate XVII, Fig 3*a*), which bears short but conspicuous antennæ. The caudal end of the body (see Plate XVII, Fig. 3*b*) bears a pair of fleshy appendges, each of which is furnished with a pair of spines similar to those on the margin of the segment, and a large number of triangular teeth.

The larva spins something like a cocoon a short distance below the surface of the ground. To this cocoon the particles of sand firmly adhere, so that it can be distinguished from the soil only with difficulty. The pupa is yellowish-white, with large black eyes. When the pupa is about to transform to an adult it emerges for about two-thirds of its length from the cocoon. The pupa skin remains firmly attached in this position (see Plate XVII, Fig. 4).

From larvæ collected at Washington May 15 the adult emerged from June 14 to June 16. I have not yet sufficient data to determine the number of generations each year; but I believe there are several. Larvæ were observed at Ithaca during the latter part of September; they went into the ground September 26.

A description of the adult is appended to this account.

The galls made by this insect have long been known. Osten Sacken,* from a study of the galls and the larva which he saw in them, proposed the name *Cecidomyia ocellaris* for the species, believing the insect to be a member of the *Cecidomyidæ*. But the fly which I have bred proves to belong to the genus *Sciara*, of the family *Mycetophilidæ*.† This result is quite interesting, for the species of Sciara are usually found "among decaying leaves, in vegetable mold, in cow-dung, under the bark of dead trees," &c.‡ One other species (*Sciara tilicola*) is known to produce a gall. This species infests the leaves of young linden trees in shady, sheltered situations. The lemon-yellow larva, capable of leaping like the cheese-maggot, lives in numbers in the stem, generally near the origin of the last or of the two last leaves. Each of them

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*Monograph of the Diptera of North Am., Part I, 199.

†I am indebted to Baron Osten Sacken for the generic determination of this insect, and for the specific determinations of the two species of *Drosophila* described in this report

‡Osten Sacken, Proc. Ent. Soc., Phil., I, 159.

has a hollow of its own, and produces a swelling of the size of a pea, which it abandons before the transformation.*

Description of adult male.—Plate XVII, Fig. 2. Head dark. Eyes black, kidney-shaped, and meeting in a point on the dorsal surface of the head. Antennæ sixteen-jointed, inserted close together; color dark brown, with the basal segment light yellowish-brown. Epicranium quite large and convex; dark brown, bearing three ocelli, which are whitish and glistening. Pronotum light yellowish-brown. Mesoscutum arched, yellowish-brown in the center and darker at the edges. Scutellum dusky brown. Metathorax dark brown, almost black. Abdomen, with caudal portions of segments, blackish, the cephalic portions yellowish-brown. The claspers lighter brown. Poisers, with knob, blackish, and base light brown. Tibiæ and tarsi dusky brown; femora lighter; coxæ still lighter. The distal end of each tibia furnished with two long brownish hairy brushes (Plate XVII, Fig. 2*a*).

LADYBIRDS.

(*Coccinellidæ.*)

[Plate XVIII.]

Among the most beneficial of insects are those which constitute the family Coccinellidæ, and which are popularly known as "Lady-birds." There are many species of these beetles. They are commonly found running over the surface of plants, where they prey upon other small insects, and also destroy the eggs of insects. Their larvæ are also predaceous, and are found in the same situations as are the adults. The larvæ, however, differ very much in appearance from the adult insects, as may be seen by reference to the accompanying plate. While studying Scale insects in California I found many of the Lady-birds on the trees infested by these pests, and devoted considerable attention to the study of them. The following descriptions and the figures on Plate XVIII will enable the reader to recognize the more common species of the Pacific coast. And the species which occur elsewhere resemble these so much in their different stages that the plate will enable one to recognize as belonging to this family any members of it he may meet. In case of the adult of each species described here two figures are given, the smaller one indicates the size of the insect, the larger one the markings.

THE ASHY-GRAY LADYBIRD (*Cycloneda abdominalis* Say).—This little beetle was found very abundantly upon different infested trees. Its larva was found upon an olive tree extensively infested with an aphid, and as it has not been before described, we submit the following:

Description of larva.—Plate XVIII, Fig. 1. Length, when full grown, 10^{mm}; color spotted with dirty greenish-white; black and orange above; face yellow, remainder of head black; prothorax black, irregularly margined before and behind with light yellow; mesothoracic segment with a broad longitudinal dorsal yellow stripe; metathoracic segment with a broad central dorsal spot; each of the abdominal segments, except the last, with a dorsal yellow spot, which upon the fourth abdominal segment is very broad; segments 1 and 4 each with a pair of subdorsal yellow spots; all segments except the last with a row of lateral yellow spots on each side. There is a pair of small subdorsal black spots to

* Osten Sacken, Proc. Ent. Soc., Phil., I, 164.

each abdominal segment, and much larger ones to the meta- and meso-thoracic segments. Upon abdominal segments 2, 3, 5, 6, 7, and 8 is also a pair of small dorso-sublateral black spots.

When about to transform to a pupa this larva attaches itself to a leaf by the end of its abdomen, and the skin, splitting at the back of the head, shrinks back about the posterior end of the body.

Description of pupa.—Plate XVIII, Fig. 2. Length, 5mm; shape, broad oval, the width being about 3.5mm; general color white, tinged in some lights with purplish; around margin slightly yellowish; wing-covers yellowish; all spots black, those on the thorax and wing-covers resembling in form, size, and position those on the adult insect. On the dorsum of each abdominal segment except the first, is a transverse row of four black spots. These are largest on the third segment and decrease in size toward posterior end of body, those upon the second segment being very small. There are also small black lateral spots on the third and fourth, and a trace of one on the fifth segment.

The adult beetle is a small ashy-gray insect of the usual semi-globular shape. There are seven black spots on the thorax, and eight upon each wing-cover, of the size and shape indicated in the figure (Plate XVIII, Fig. 3).

THE BLOOD-RED LADYBIRD (*Cycloneda sanguinea*, Linn).—This species was not so common as the one just described, and we are only able to describe the pupa.

Description of pupa.—Plate XVIII, Fig. 4. Length, 5mm; width, 3.5mm. Shape, broadly oval. General color of body dirty yellow; median line of thorax of a light orange color; first, fourth, and fifth abdominal segments terminate laterally with bright orange-colored spots, and the fourth abdominal segment bears two dorsal spots (one on each side of the median line) of the same color; there is also a subdorsal row of black spots on each segment except the second abdominal; wing-covers blackish.

The adult beetle is small (5mm long), and is almost hemispherical in shape. Its color varies from brick-red to blood-red; thorax black, with two orange spots, and edged with the same color, and head black, with two light spots. (Plate XVIII, Fig. 5.)

This is a common species all over the country, and is frequently mentioned in entomological reports, under Say's name of *Coccinella munda*, as preying upon injurious insects.

THE LADYBIRD OF THE CACTUS (*Chilocorus cacti*, Linn.).—A number of the larvæ of this insect were found preying upon the black scale upon oleander, and the beetles themselves were found abundantly upon different plants.

Description of larva.—Plate XVIII, Fig. 7. Length, 6mm. The body is covered with many long spines, each of which is armed with delicate supplementary spines. The color is entirely black, with the exception of first abdominal segment, which is light yellowish, the spines of the same color as the segment except at the tips, where they, too, are black.

Description of pupa.—Plate XVIII, Fig. 8. The pupais formed within the larval skin, which simply splits along the back sufficiently to show the inclosed pupa, but still remains around it and protects it. The pupa is perfectly smooth with the exception of sparsely-scattered tufts of fine hair, shining and black in color.

The beetles themselves are shining black in color, with an irregular reddish spot on each wing cover, and closely resemble the "Twice-stabbed Lady-bird" of the East (*Chilocorus bivulnerus* Muls.), well known to writers on economic entomology as destroying many injurious insects, particularly bark lice. (Plate XVIII, Fig. 9.)

THE AMBIGUOUS HIPPODAMIA (*Hippodamia ambigua* Lec.).—This was one of the most abundant Lady-birds found. The beetles and larvæ abounded on all sorts of trees, and are undoubtedly of much economic importance.

Description of larva.—Plate XVIII, Fig. 10. Length, when full grown, 10^{mm}. Color bluish black above, dirty green below; first thoracic segment margined with yellowish white; abdominal spots bright orange and black. The orange spots are arranged as follows: Two small spots on the posterior part of the metathoracic segment and a larger one on each side just above the leg; first abdominal segment with large subdorsal and lateral spots; second abdominal segment with small lateral spots, which are really the endings of two long lateral spots, beginning on the metathorax and extending across the first abdominal segment, fourth abdominal segment, with subdorsal and lateral spots a little smaller than those on the first; sixth, and seventh, each with small subdorsal spots.

Description of pupa.—Plate XVIII, Fig. 11. Length, 6^{mm}; width, 3.5^{mm}; general color dull orange yellow; prothorax yellow, with a dark, sometimes black, margin, a black spot on either side the median line on both front and hind margins, also another on each side just external to those on the hind margin. In some specimens there are two dusky discal spots on the prothorax, which sometimes extend forward and unite with the middle anterior marginal spots. The wing-cases are tipped with black; the legs are black, and the abdomen furnished above with a double row (almost, if not quite, continuous) of black spots.

The adult beetle resembles the Blood Red Lady-bird, but is narrower in proportion to its length, and is flatter. The thorax is black, with its two fore-corners dirty white. The head is black, with the middle of the forehead whitish. It is about 6^{mm} long. (Plate XVIII, Fig. 12.)

Three other species were observed in the vicinity of Los Angeles, but I was unable to procure specimens illustrating the early stages of these species. The adults are represented on the plate, and are as follows: Fig. 6 represents *Cycloneda oculata;* this beetle has black wing-covers, with a large reddish spot on each. Fig. 13 represents *Coccinella 5-notata*, variety *californica*. In this variety the prothorax is black and the wing-covers pale orange. And Fig. 14 represents *Hippodamia convergens*, a species which is common throughout the United States.

METHODS OF DESTROYING SCALE INSECTS.

[We must enter our dissent from the conclusions and opinions here recorded and indorsed by Professor Comstock, as also those published by him in the last year's report in regard to the relative merits of kerosene, properly used, and lye, as agents for the destruction of Scale-insects. Years ago we used kerosene successfully against them by simple mechanical stirring of it in water, while we have more recently witnessed its effects when used in proper emulsion. The careful and thorough experiments by Mr. Hubbard, recorded in his report which precedes, are conclusive, and their accuracy is confirmed, not only by practical experience in his own groves, but by extensive experience of others. We have also personally examined and corroborated the results. They show that lye bears no comparison with the kerosene emulsion, and that whale-oil soap, while useful, is also inferior to kerosene, as it fails to kill the eggs.

The discrepancy in the experience on the Pacific coast and in Florida can scarcely be due to the different species to be dealt with, but must evidently be explained by differences in methods, materials, and thoroughness. We should be sorry to have the California orange-growers deterred from the proper use of kerosene in emulsion, when it has proved so satisfactory in the East. Professor Comstock's experience with it has been unfortunate, in that it has been limited chiefly to some experiments made by Mr. William Trelease—not on orange-tree *Diaspinæ*, but on other coccids in the Department grounds. He has never used it for this purpose in emulsion, and has, in fact, not understood the principles that should govern, whether in making the emulsion or in its effectual and satisfactory use.—C. V. R.]

In the Agricultural Report for 1880, pages 285–290, I gave the results of certain experiments in the destruction of Scale-insects. Since the publication of that report I have been unable to continue my investigations; but some of my correspondents have conducted very extensive experiments in this direction, with very gratifying results. The following letters will indicate the importance of these results:

STATE OF CALIFORNIA,
BOARD OF STATE HORTICULTURAL COMMISSIONERS,
San José, Cal., February 27, 1882.

DEAR SIR: Your favor of February 11 received. In answer to your questions, I will say that the results from the use of concentrated lye, one pound to one gallon water, are most effectual in the destruction of the Scale insect. And in my judgment it is the best remedy, and the one which gives the greatest satisfaction here where used properly. By the use of this remedy, I will say, without reserve or any qualification, that my young orchard has been freed from Scale insects; and that all who will use like care may do the same. Many of the old orchards here that have been seriously injured by the scale *Aspidiotus perniciosus* are being washed thoroughly with lye of the above strength, and with the result of destroying all the Scale insects that the lye reaches. The lye does not destroy the fruit-buds of the trees when applied while they are dormant. As illustrating this I will instance my almond trees, which were washed a month since with lye, one pound to one gallon of water, by spray, covering the entire trees thoroughly, and are now in full bloom. I washed to destroy the eggs of the Red Spider. This strength of lye will dry up and destroy the greater part of these eggs. The effect of lye of this strength on the eggs of the oyster-shell bark-louse you also ask about. This is effectual in drying up the shell-like scale and the *eggs* under it. I find that lye destroys any form of Scale insect, and in my opinion will be the remedy most resorted to for this purpose. An analysis of the "American concentrated lye" by Professor Hilgard, at my request, and as forwarded to me, is given:

Caustic potash	8.3
Caustic soda and some carbonate soda	91.7
	100.

The soda is, of course, not desirable to use steadily on the soil;* but it is certain the combination is a most effectual one for the purpose of destroying this dreaded Scale, so hard to be reached in any other way. No other remedy but refined kerosene of a low grade is at all used now. That is being used extensively here, and will destroy the Scale, of course, but its effects on the future of the tree cannot yet be told. And I am afraid it may prove to be an undesirable wash hereafter. Crude petroleum, so extensively used a year ago, is not now used at all, as most of the trees washed with it were killed. The whale-oil soap and sulphur mixture (which has in it considerable potash) is a remedy of great value if used in the summer, about May or June, in the proportion of one pound soap to one gallon water.†

This is the only remedy besides the lye that I can recommend; the lye to be used when the tree is dormant, and to be supplemented by, *if needed*, the whale-oil soap and sulphur mixture in the spring or summer. With these two I am confident the Scale can be cleaned out of our orchards, if persistently and carefully attended to.

*I have made careful inquiry of an agricultural chemist, and am unable to find that any ill effects upon the soil can be expected from the use of soda in this way.—J. H. C.

†My experiments led me to believe that one-fourth pound soap to one gallon water was strong enough to kill the Scale insects.—J. H. C.

As many object to the strength of such remedies, it must be said that such a serious pest as we have to encounter in the *Aspidiotus perniciosus* must be treated with vigor and with remedies strong enough to utterly destroy it.

* * * * * * *

I am, very truly, yours,

S. F. CHAPIN.

Professor COMSTOCK.

The following is from the chief executive horticultural officer of California:

SACRAMENTO, CAL., *June* 1, 1882.

* * * * * * *

In regard to remedies, I have tried, and recommended others to try, various experiments, and have been successful beyond doubt.

1. Nursery trees dipped in a solution of one pound of American Company's concentrated lye to each one and a half gallons of water will be perfectly cleaned of *A. perniciosus*, *A. rapax*, or any other of the Aspidiotus except *A. conchiformis* [*Mytilaspis pomorum*].

2. Nursery trees dipped in a solution as above, but one pound to each one gallon of water, will be perfectly cleared of *A. conchiformis* [*M. pomorum*].

3. The roots of nursery trees should be dipped in soap and sulphur (soap two parts, sulphur one part), one pound to each gallon of water.

4. Fruit trees, apple, pear, quince, cherry, plum, &c., washed before the sap commences to run or buds begin to swell with one pound of American concentrated lye to each gallon of water will be effectually cleaned of Aspidiotus and Lecanium Scale insects.

5. Cherry and plum trees covered with Aspidiotus Scales and red spider were washed, as an experiment, with two pounds of American concentrated lye to one gallon of water. Insect life all destroyed, and trees bearing a large crop of fruit at present.

6. Low-grade coal-oil, costing here about fourteen cents per gallon, has been used to a great extent around San José, although I advised them not to use mineral oils. Result, trees look unhealthy, lower fruit buds killed. In one orchard all peach trees killed. Also many young apple orchards destroyed.

7. The salvation of the fruit industry on this coast will be the use of alkaline washes and tobacco washes.

* * * * * * *

Respectfully,

MATTHEW COOKE.

The two letters given above show as clearly as need be the practical results which the California fruit-growers have been able to obtain in their efforts to destroy Scale insects. A word more may be necessary to explain the method of applying the washes used.

In the case of small plants and nursery trees the spraying will be a simple matter. But in case of large trees the best way is to place a large barrel or cask containing the liquid on a platform wagon, which can be drawn through the orchard by horses. The fluid may be thrown on to the trees by any one of the force-pumps sold for that purpose. The one which appears to be used most extensively in California is known as the Merigot force-pump. Attached to the end of the hose there should be something for making a fine spray. My California correspondents state the "Merigot spray-tip nozzle" is the best thing of this kind yet used in that State. Mr. Chapin has suggested an attachment to an apparatus of this kind which has proved of great value. A three-sixteenth inch brass tube is inserted in a bamboo rod; one end is attached to the hose of the force-pump, and the other end bears the spray-tip nozzle. This tube and rod are made of any length desired, up to 15 feet. The length most commonly used is from 8 to 10 feet, this being found most convenient. The bamboo is used as the lightest and strongest support obtainable for the slender brass tube, which would bend under its own weight if not supported. By means of this apparatus it is perfectly easy to spray the largest orchard trees without being injured by the strong lye used. Mr. Chapin has generously

EXPLANATION TO PLATES.

Explanation to Plate I.

Heliothis armigerà.

(From Report 4, U. S. E. C.)

Fig. 1.—Egg.

Fig. 2.—Young larva.

Fig. 3.—Square gnawed into by young larva.

Fig. 4.—Pale yellowish larva, with boll gnawed and eaten into.

Fig. 5.—Full grown larva, normal colors.

Fig. 6.—Chrysalis in earthen cell.

Fig. 7.—Moth with ochreous tint.

Fig. 8.—Moth with olivaceous tint.

Fig. 9.—Moth at rest, showing how wings remain partly open.

Explanation to Plate II.

Leucania unipuncta.

(From Report 4, U. S. E. C.)

Fig. 1.—Glistening secretion which often shows where eggs are laid between fold of green leaf.

Fig. 2.—Young larva.

Figs. 3, 4, 5.—Full-grown larvæ, ventral, dorsal, and lateral views.

Fig. 6.—Larva, showing Tachina eggs near head.

Fig. 7.—Pupa.

Fig. 8.—Moth with wings expanded.

Fig. 9.—Moth showing normal position of wings when closed, back view.

Fig. 10.—Pale specimen of moth from side.

Explanation to Plate III.

Pyrethrum roseum.

(Original.)

Showing variation in leaf and in color of flower, as grown by C. V. Riley.

Explanation to Plate IV.

Pyrethrum cinerariæfolium.

(Original.)

Showing variation in leaf, as grown by C. V. Riley.

Explanation to Plate V.

Scale insects on orange.

(From Comstock's Report for 1880.)

Fig. 1.—*Mytilaspis citricola* (Pack.): 1, scales on orange, natural size; 1*a*, scale of female, dorsal view; 1*b*, scale of female with ventral scale and eggs; 1*c*, scale of male—enlarged.

Fig. 2.—*Mytilaspis Gloverii* (Pack.): 2, scales on orange, natural size; 2*a*, scale of female, dorsal view; 2*b*, scale of male; 2*c*, scale of female with ventral scale and eggs—enlarged.

Fig. 3.—*Parlatoria Pergandii* Comst.: 3*a*, scale of female; 3*b*, scale of male—enlarged.

Explanation to Plate VI.

Fig. 1.—*Leucania unipuncta*, full-grown larva. (After Riley.)

Fig. 2.—*Leucania unipuncta*, genitalia of male moth: *A*, end of body, denuded of hairs, showing the upper clasps protruding, and the natural position of the hidden organs by dotted lines; *B*, the organs extruded—enlarged. (After Riley.)

Fig. 3.—*Leucania unipuncta*, ovipositor of female moth: *a*, end of abdomen denuded and showing ovipositor at rest; *b*, same with ovipositor fully extended; *e*, *f*, retractile subjoints; *h*, eggs—enlarged; *g*, eggs, natural size. (After Riley.)

Fig. 4.—*Lissorhoptrus simplex* (Say): *a*, larva, side view; *b*, under side of head, showing mouth-parts, the mandibles omitted so as to show more clearly the position of the parts in relation to the face; *c*, labrum and antenna; *d*, beetle, dorsal view; *e*, do., outline, side view—enlarged. (Original.)

Fig. 5.—*Chalepus trachypygus* Burm.: *a*, beetle; *b*, larva, natural size; *c*, head-parts from beneath, enlarged; *d*, mandibles; *e*, antennæ; *f*, maxillæ, with their palpi; *g*, labium, with its palpi. (Original.)

Explanation to Plate VII.

Fig. 1.—*Chilo oryzæellus* n. sp.: *a*, larva, side view, in split stem; *b*, do., back view; *c*, pupa; *d*, female moth—natural size; *e*, tip of pupa from beneath; *f*, head of do. from side—enlarged. (Original.)

Fig. 2.—*Rhodobænus 13-punctatus* (Ill.): *a*, beetle, dorsal view, showing markings; *b*, do., outline side view—enlarged. (After Riley.)

Fig. 3.—*Pempelia lignosella* Zell.: *a*, stalk, showing work of larva; *b*, larva; *c*, pupa; *d*, *d*, moth with wings expanded and at rest—natural size; *e*, middle joint of larva, dorsal view; *f*, do., side view; *g*, *h*, wings of moth showing variation; *i*, head of male with mouth-parts denuded; *j*, maxillary palpus, male; *k*, do., female; *l*, labial palpus, female; *m*, base of antenna, male, dotted lines indicating outline of scales—enlarged. (Original.)

FIG. 4.—*Laphygma frugiperda* (Sm. & Abb.): *a*, larva, natural size; *b*, head from front; *c* a middle joint from above; *d*, do. from side—enlarged. (After Riley.)

FIG. 5.—*Laphygma frugiperda*: *a*, moth, normal form; *b*, wings of variety *fusca*; *d*, do. of variety *obscura*—natural size. (After Riley.)

EXPLANATION TO PLATE VIII.

FIG. 1.—*Anomis erosa* Guen.: *e*, full-grown larva at rest; *f*, do., walking, side view; *k*, cocoon; *l*, pupa, side view; *o*, moth wings expanded; *p*, do., wings closed—natural size; *a*, egg, top view; *b*, do., side view; *c*, sculpture of same, highly magnified; *g*, middle joint of larva, top view; *h*, do., side view; *i*, head of larva from above; *j*, anal joint of same from above; *m*, tip of pupa from above; *n*, do., from side—enlarged. (Original.)

FIG. 2.—*Sphenophorus robustus* Horn: *a*, larva; *b*, pupa; *c*, beetle, dorsal view; *d*, do., outline, side view—natural size. (Original.)

EXPLANATION TO PLATE IX.

Spraying machine, devised for the protection of cotton.

(Original.)

FIG. 1.—Mode of attachment to wagon.

FIG. 2.—Skid on which barrel rests.

FIG. 3.—Section of barrel showing action of pump. (For detailed explanations see text, pp. 159–162.)

EXPLANATION TO PLATE X.

FIG 1.—*Phytonomus punctatus* (Fabr.): *b*, *b*, *b*, *b*, larvæ feeding; *f*, cocoon; *i*, beetle—natural size; *a*, egg; *c*, recently hatched larva; *d*, its head from beneath; *e*, its jaw *g*, meshes of cocoon; *h*, pupa; *k*, beetle, dorsal view; *j*, do., outline, side view; *l*, its tarsus; *m*, its antenna—enlarged. (Original.)

FIG. 2.—*Crambus vulgivagellus*: *a*, larva; *b*, web of same; *c*, cocoon; *d*, moth, dark specimen; *e*, wing of light specimen; *f*, moth at rest—natural size; *g*, egg, enlarged, natural size shown at side. (Original.)

EXPLANATION TO PLATE XI.

(Original.)

Nola sorghiella n. sp.: *a*, head of chicken corn showing ravages of the insect; *b*, larva, side view; *c*, do., back view; *d*, cocoon; *e*, chrysalis; *f*, moth—natural size; *g*, middle joint of larva from side; *h*, moth; *i*, labial palpus; *j*, maxillary palpus; *k*, basal joint of antenna in ♂; *l*, venation of front wings; *m*, do., hind wings—enlarged.

EXPLANATION TO PLATE XII.

FIG. 1.—*Heliothis armigera*: Larva feeding in tomato. (After Riley.)

FIG. 2.—*Ceratomia Hageni* Gr.: *a*, larva; *b*, moth, pale or normal form; *c*, front wing of dark variety—natural size. (Original.)

FIG. 3.—*Isosoma tritici* Riley: *a*, larva, ventral view; *b*, do., lateral view; *c*, antenna; *d*, mandibles; *e*, anal end, ventrally; *f*, imago; *g*, *h*, front and hind wings of exceptional individuals; *i*, aborted wing in the normal flies—all relatively en-enlarged. (Original.)

EXPLANATION TO PLATE XIII.

(Original.)

Sphinx catalpæ Boisd.: *a*, egg-mass; *b*, newly-hatched larvæ; *c*, a larva one-third grown; *d*, dorsal view of one of its joints; *e*, *f*, *h*, differently marked larvæ; *g*, dorsal view of one of the joints of *f*; *i*, do. of *h*; *j*, pupa; *k*, moth—natural size; *l*, egg enlarged.

EXPLANATION TO PLATE XIV.

Trypeta pomonella Walsh.

(Original.)

FIG. 1.—Larva; 1*a*, lateral view of head of larva; 1*b*, cephalic aspect of the same; 1*c*, right caudal spiracle.

FIG. 2.—Puparium.

FIG. 3.—Adult.

EXPLANATION TO PLATE XV.

Drosophila ampelophila Loew.

(Original.)

FIG. 1.—Adult.

FIG. 2.—Ventral aspect of puparium.

FIG. 3.—Lateral aspect of puparium.

FIG. 4.—Tarsus of prothoracic leg of adult male; 4*a*, tarsal appendage.

FIG. 5.—Cephalic spiracle.

FIG. 6.—Lateral aspect of cephalic end of larva.

FIG. 7.—Egg.

FIG. 8.—Larva.

EXPLANATION TO PLATE XVI.

Drosophila amœna Lœw.

(Original.)

FIG. 1.—Larva; 1*a*, head of same; 1*b*, cephalic spiracle of same; 1*c*, caudal spiracle of same.

FIG. 2.—Puparium.

FIG. 3.—Adult.

EXPLANATION TO PLATE XVII.

Sciara ocellaris O. S.

(Original.)

FIG. 1.—Leaf of *Acer rubrum*, with galls.

FIG. 2.—Adult, male; 2*a*, tibial spurs and brushes of the same; 2*b*, claspers of the same.

FIG. 3.—Larva; 3*a*, head of larva; 3*b*, caudal end of larva.

FIG. 4.—Cocoon and pupa skin.

EXPLANATION TO PLATE XVIII.

Coccinellidæ.

(Original.)

FIGS. 1, 2, 3.—Larva, pupa, and adult of *Cycloneda abdominalis*.

FIG. 4, 5.—Pupa and adult of *Cycloneda sanguinea*

EXPLANATION TO PLATES.

FIG. 6.—*Cycloneda oculata.*
FIGS. 7, 8, 9.—Larva, pupa, adult of *Chilocorus cacti.*
FIGS. 10, 11, 12.—Larva, pupa, adult of *Hippodamia ambigua.*
FIG. 13.—*Coccinella 5-notata*, var. *californica.*
FIG. 14.—*Hippodamia convergens.*

EXPLANATION TO PLATE XIX.

FIG. 1.—*Carteria mexicana* n. sp.: 1, twig with masses of lac, each containing an insect; 1a, young female; 1b, 1c, two views of spine of female; 1d, adult female; 1e, end of lac tube, with perforated plate; 1f, anal tubercle; 1g, spiracle; 1h, anal ring. (Original.)

FIG. 2.—*Carteria lacca* (Kerr): 2, mass of lac from twig, natural size; 2a, same enlarged, with insects; 2b, lac tube, with perforated plate at extremity and spiracle at base; 2c, spine and tubercle which bears it; 2d, fleshy appendages of anal end of body; 2e, anal tubercle; 2f, part of anal ring; 2g, part of fringe about anal ring. (Original.)

EXPLANATION TO PLATE XX.

FIG. 1.—*Carteria larreæ* n. sp.: 1, twig with masses of lac, natural size; 1a, single specimen of female, with the greater part of the lac dissolved away; 1b, sac of male; 1c, group of spinnerets of female; 1d, anal tubercle; 1e, spine; 1f, part of fringe of anal tubercle; 1g, lac tube, with perforated plate; 1h, spiracle. (Original.)

FIG. 2.—*Cerococcus quercus* n. sp.: 2, twig of oak, with insects, natural size; 2a, sac of adult female; 2b, sac of young female; 2c, portion of skin of female, with double pores, spines, and madreporiform plates; 2d, sac of male; 2e, caudal end of female; the anal ring and hairs show in optical section. (Original.)

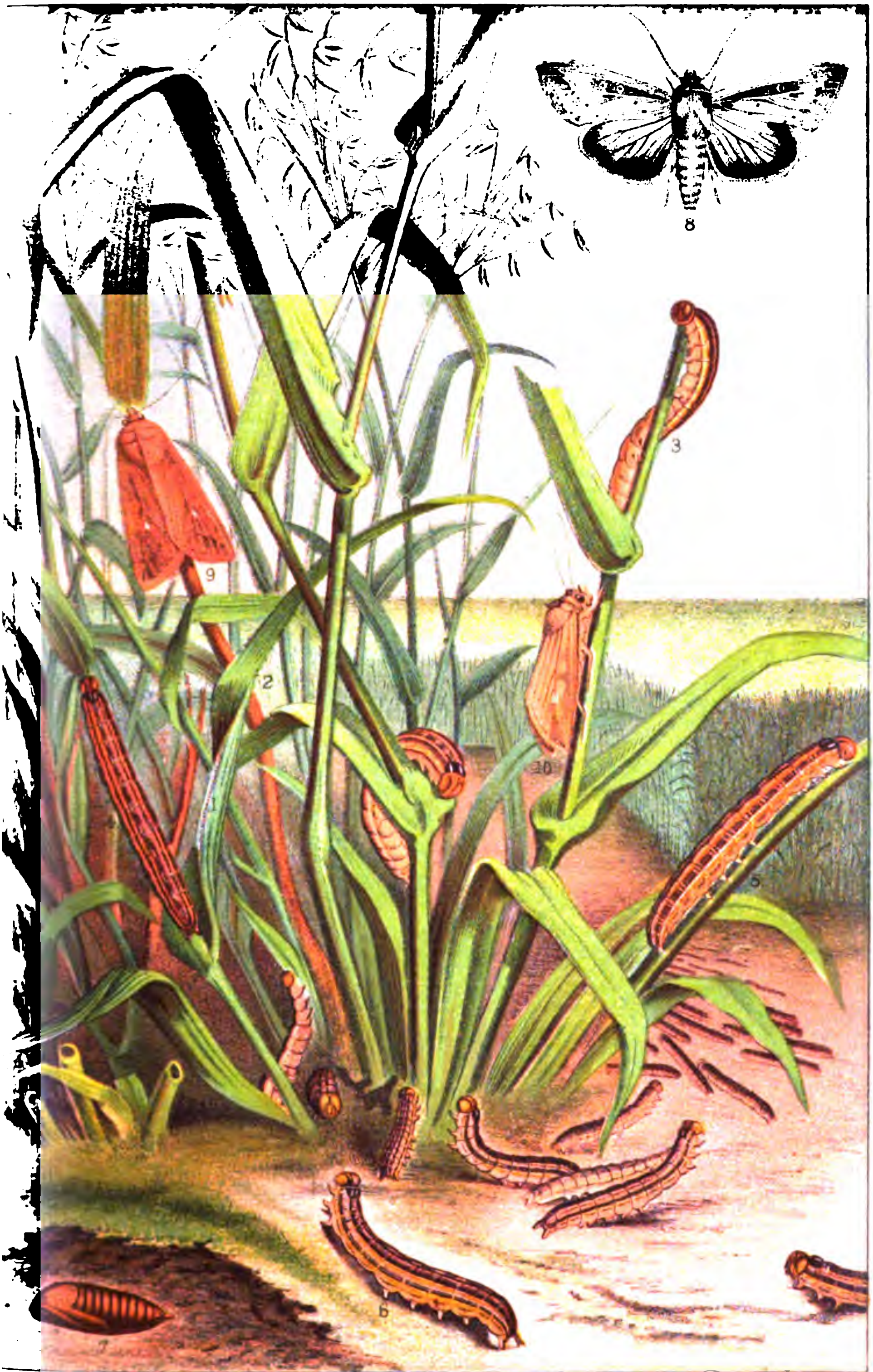
ADDENDA.

Page 127.—Since the matter on this page was in type, Lord Walsingham has, at our request, examined the type of *Diphryx prolatella* Grote in the British Museum in comparison with *Chilo oryzæellus*. The result fully justifies our remarks, and the two insects are specifically identical. The type of Diphryx is a female with the labial palpi broken off, and only the maxillary palpi remaining; so that the genus rests on no foundation in nature, and its author mistook the maxillary for labial palpi.

Page 181.—The Cryptus mentioned as parasitic on *Crambus vulgivagellus* has been kindly determined by Mr. E. T. Cresson as *C. mundus* Provancher. The specimens we have reared show no other differences from the type (a male of which we have received from M. Provancher) than that the yellow markings about the head are reddish—a difference induced, perhaps, by the cyanide of potassium with which they were killed.

THE BOLL WORM.
(Heliothis armigera.)

[illegible] WORM
[illegible]



Riley del et pinx T. Sinclair & Son, Lith

THE ARMY WORM.
(Leucania unipuncta)

Painted from plants grown by C.V. Riley

T. Sinclair & Son, Lith

PYRETHRUM ROSEUM.

Painted from plants grown by C.V. Riley

Th. Sinclair & Son, Lith.

PYRETHRUM CINERARIÆFOLIUM.

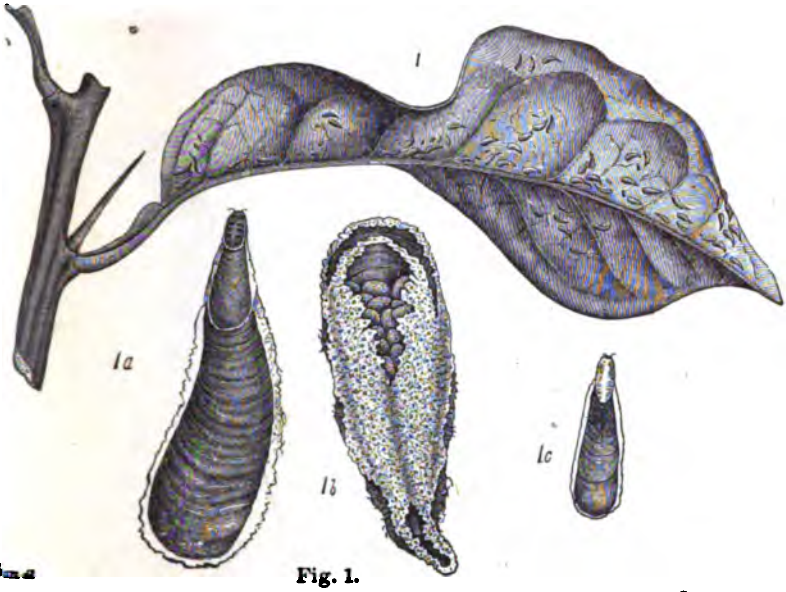


Fig. 1.

Fig. 2.

Fig. 3.

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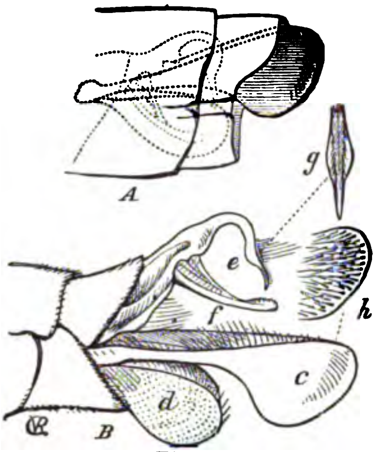

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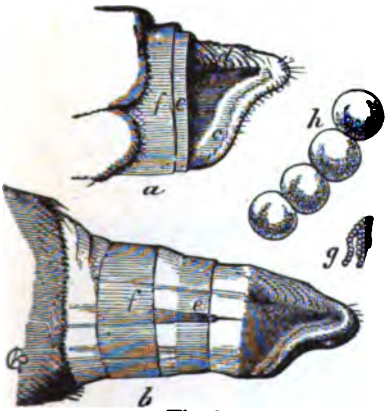

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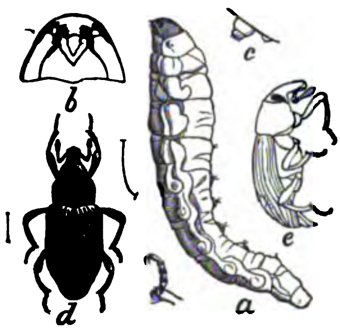

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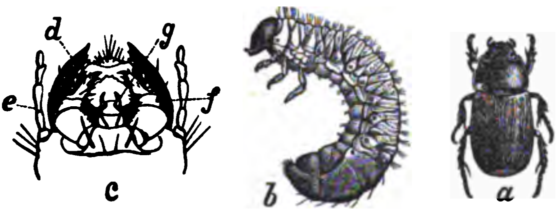

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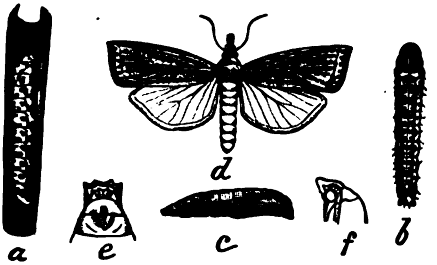

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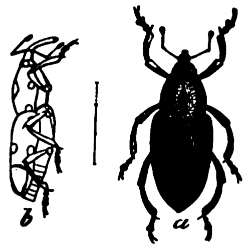

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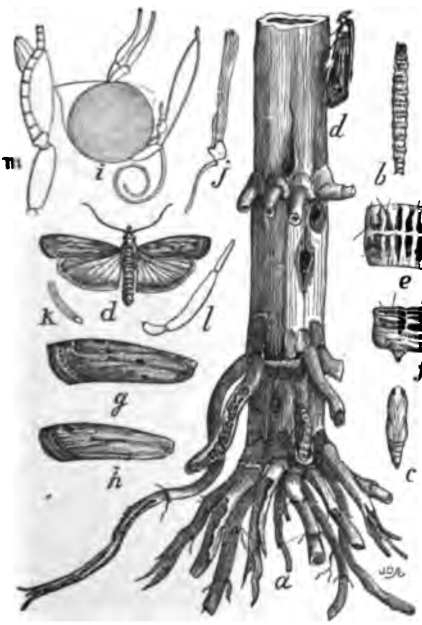

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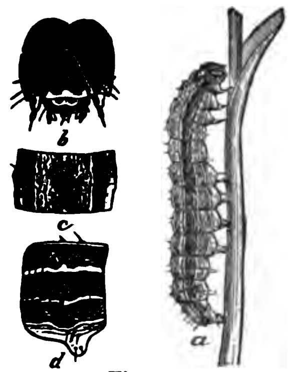

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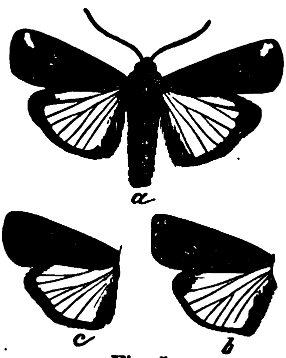

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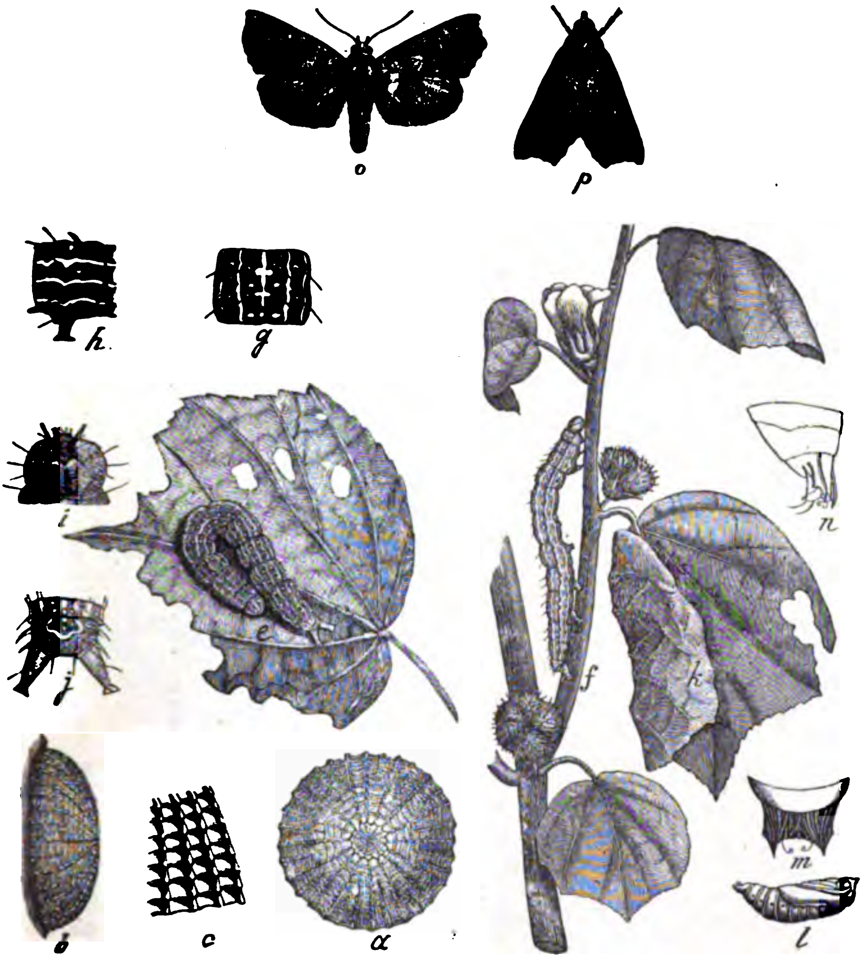

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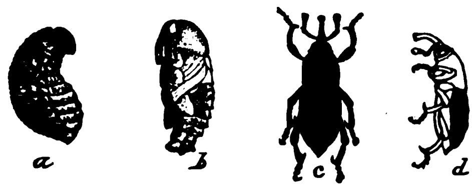

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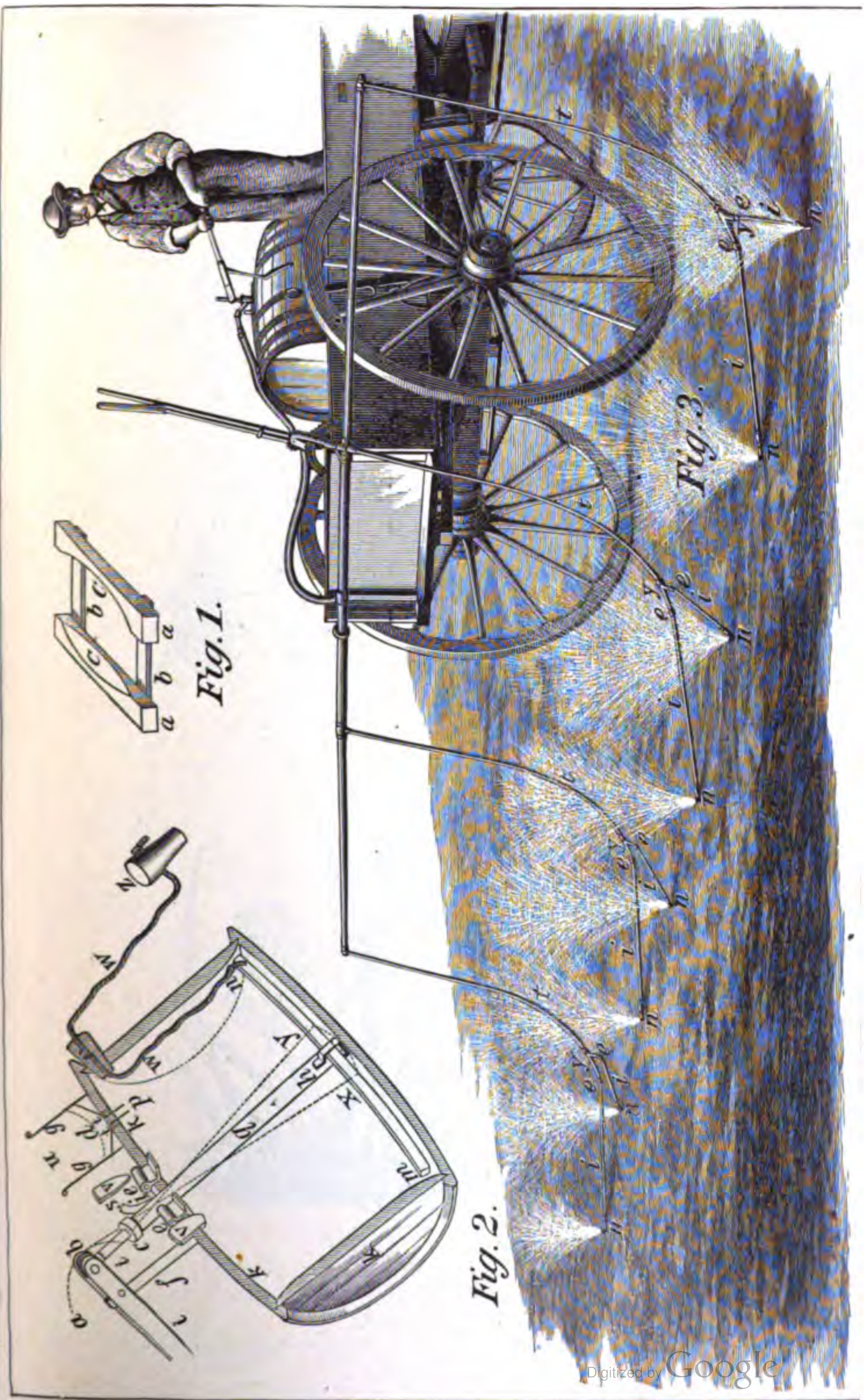

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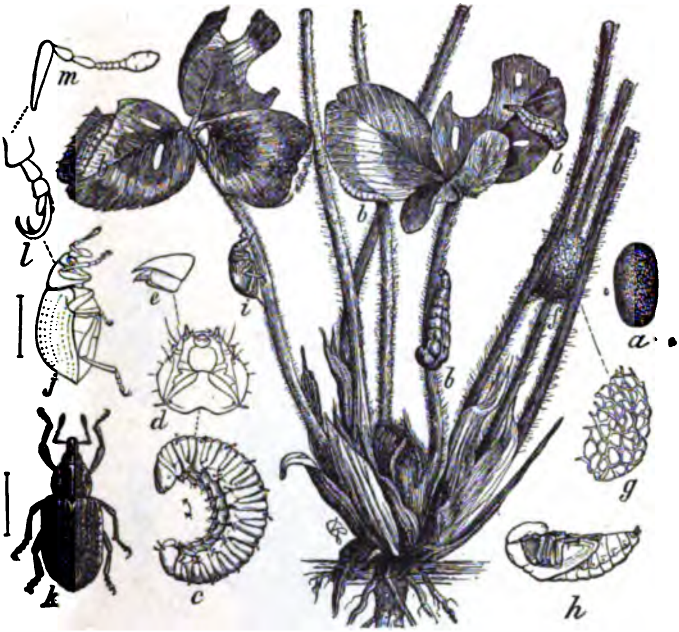

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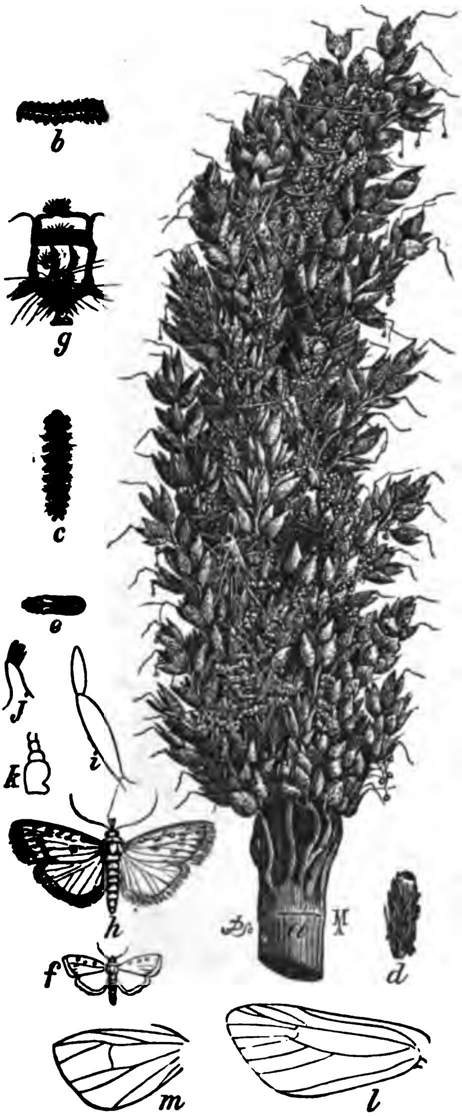
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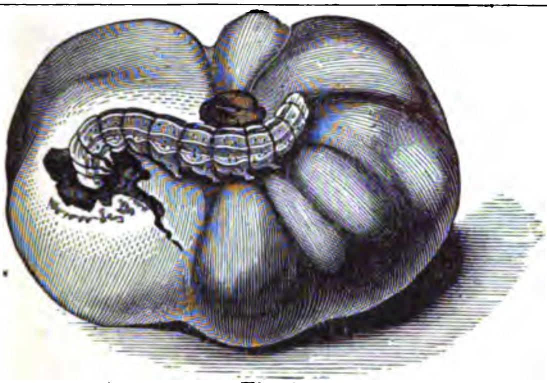

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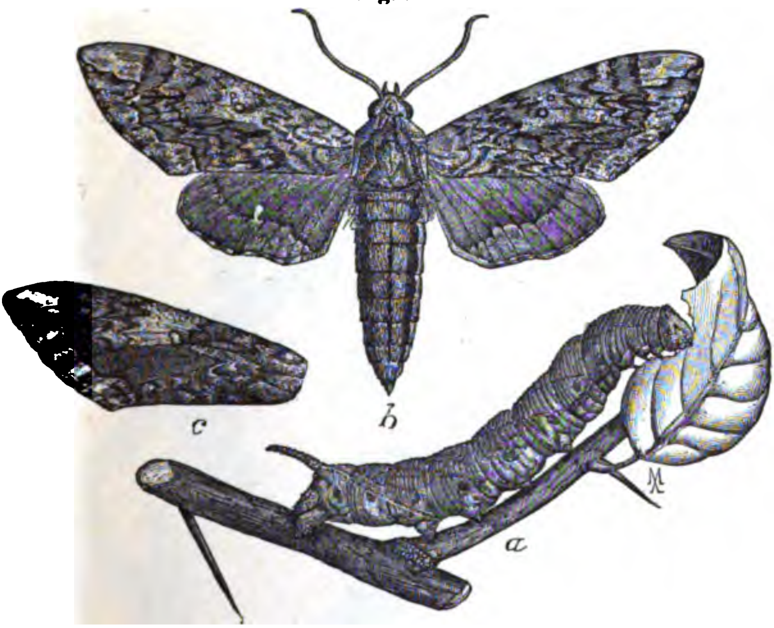

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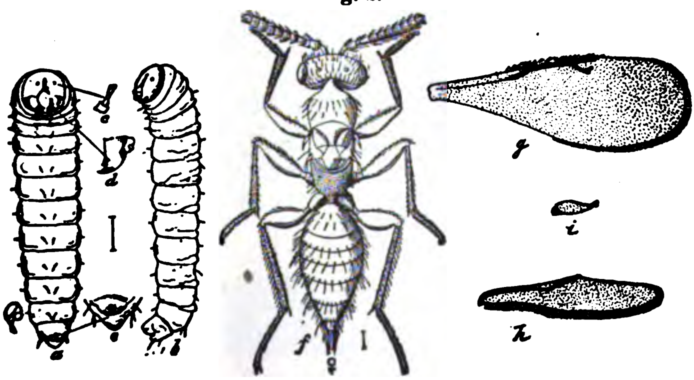

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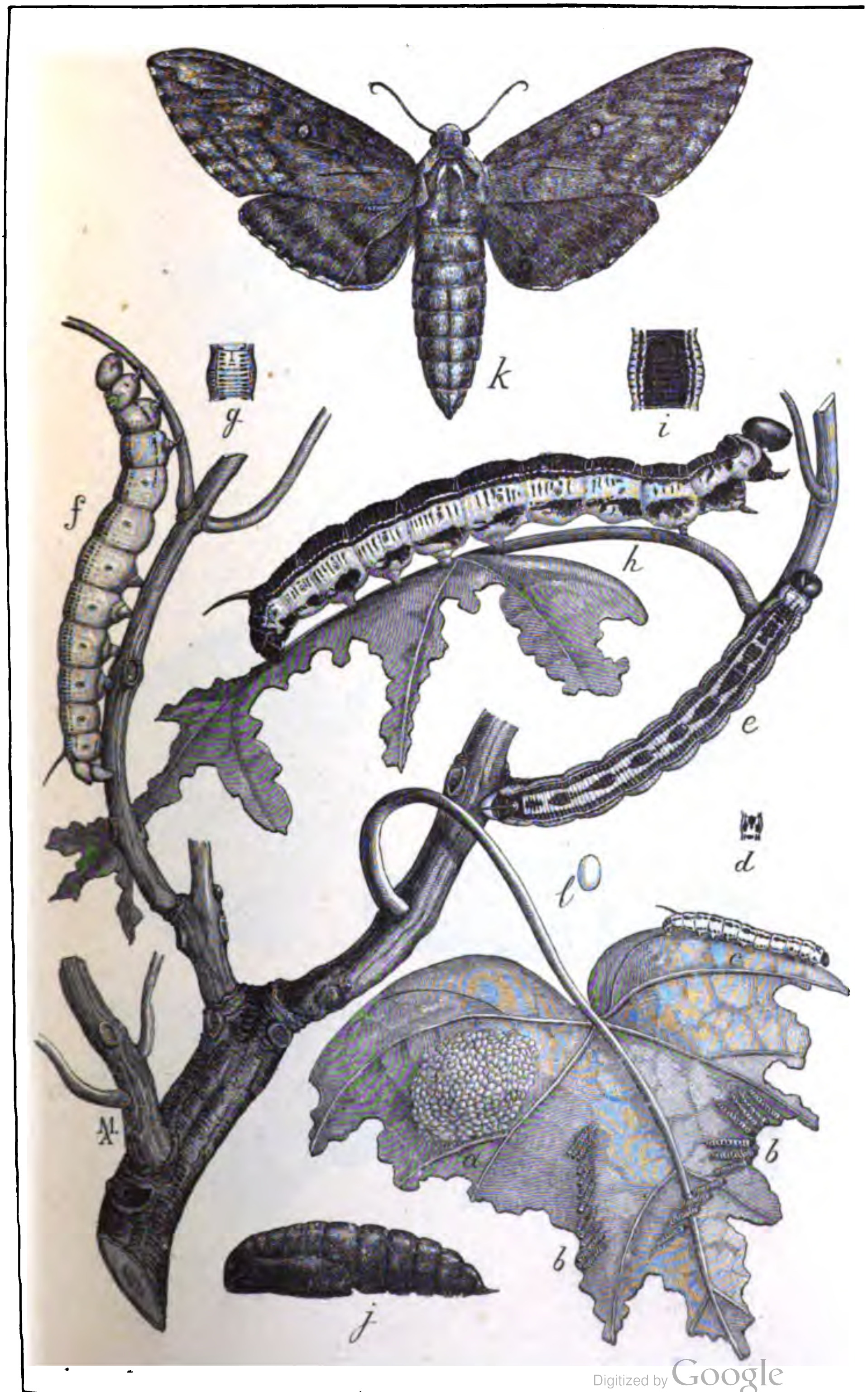
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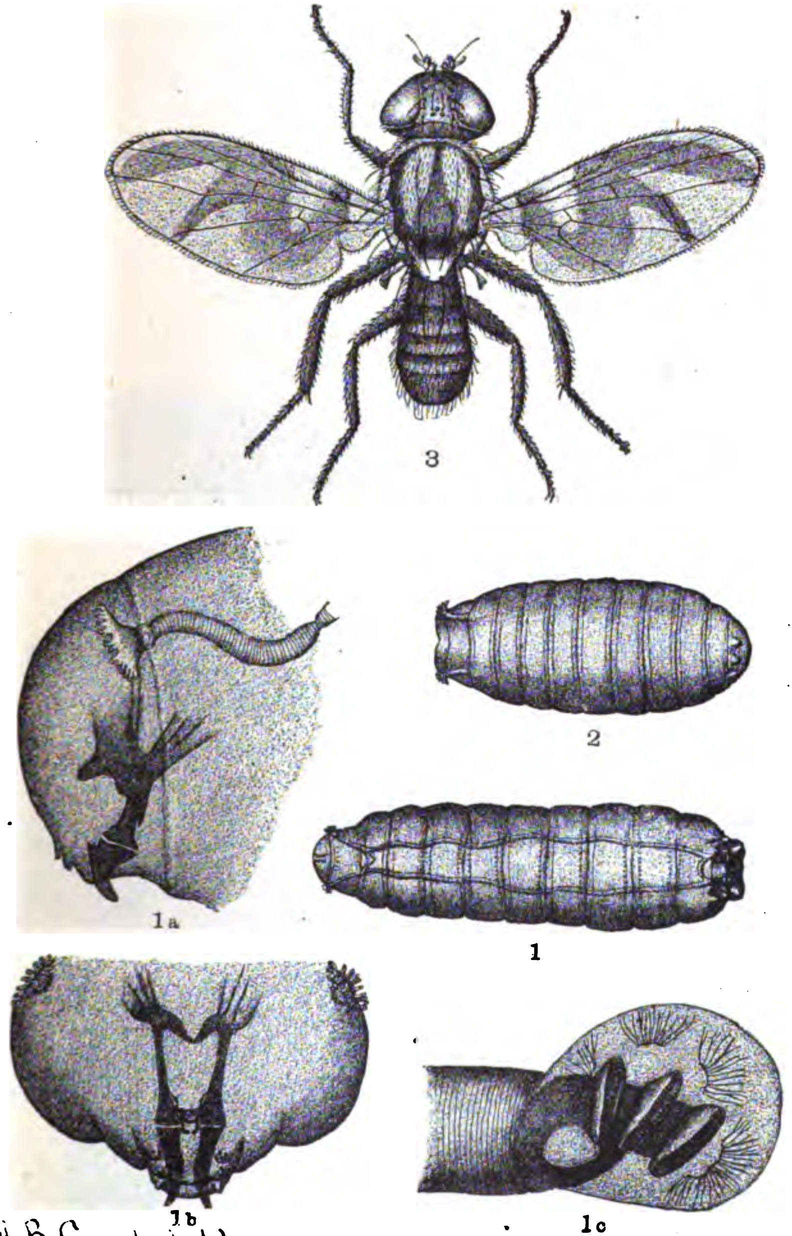

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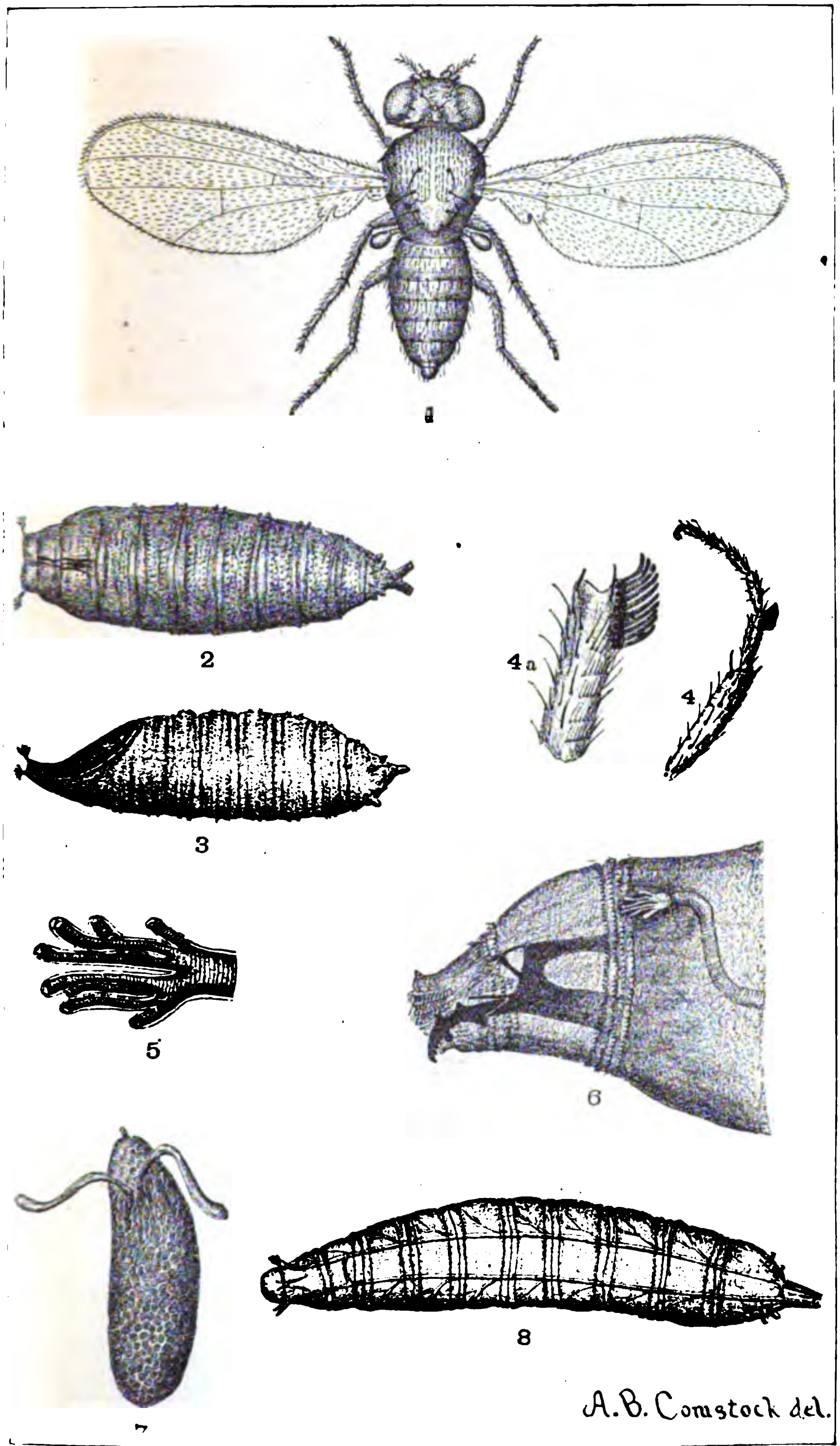
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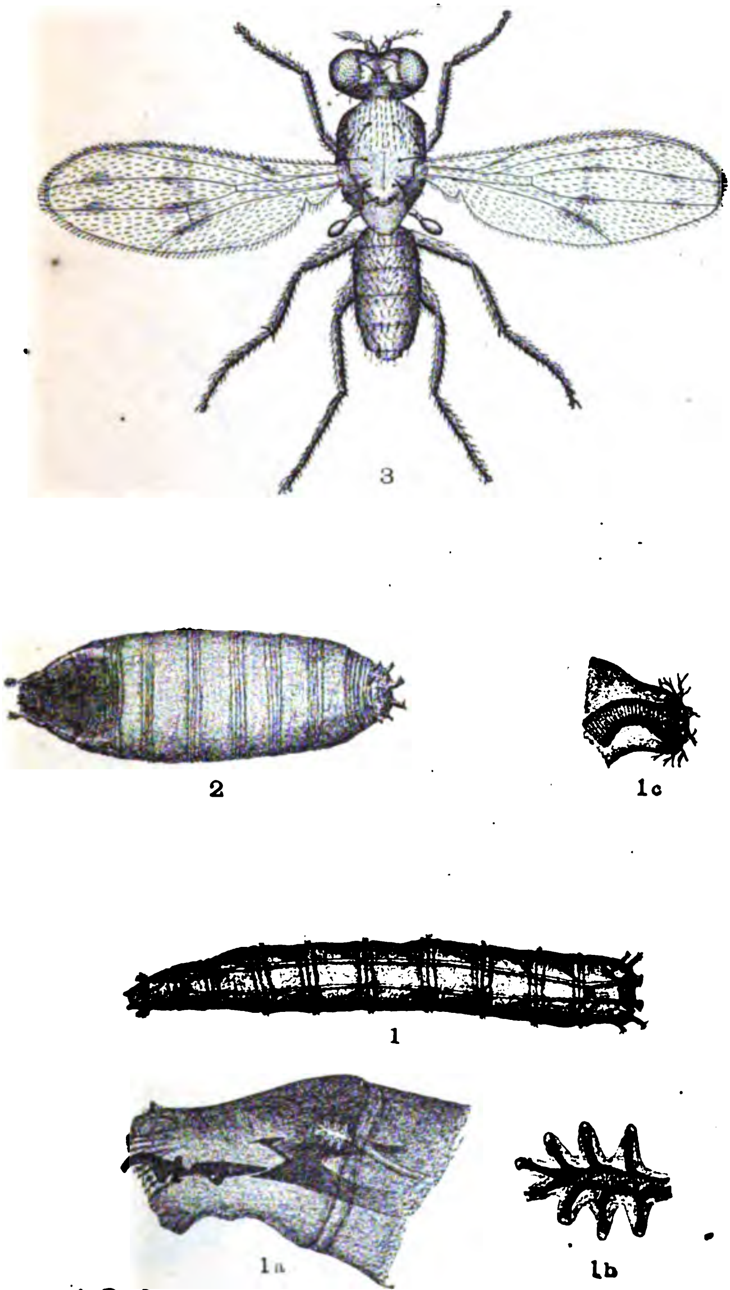

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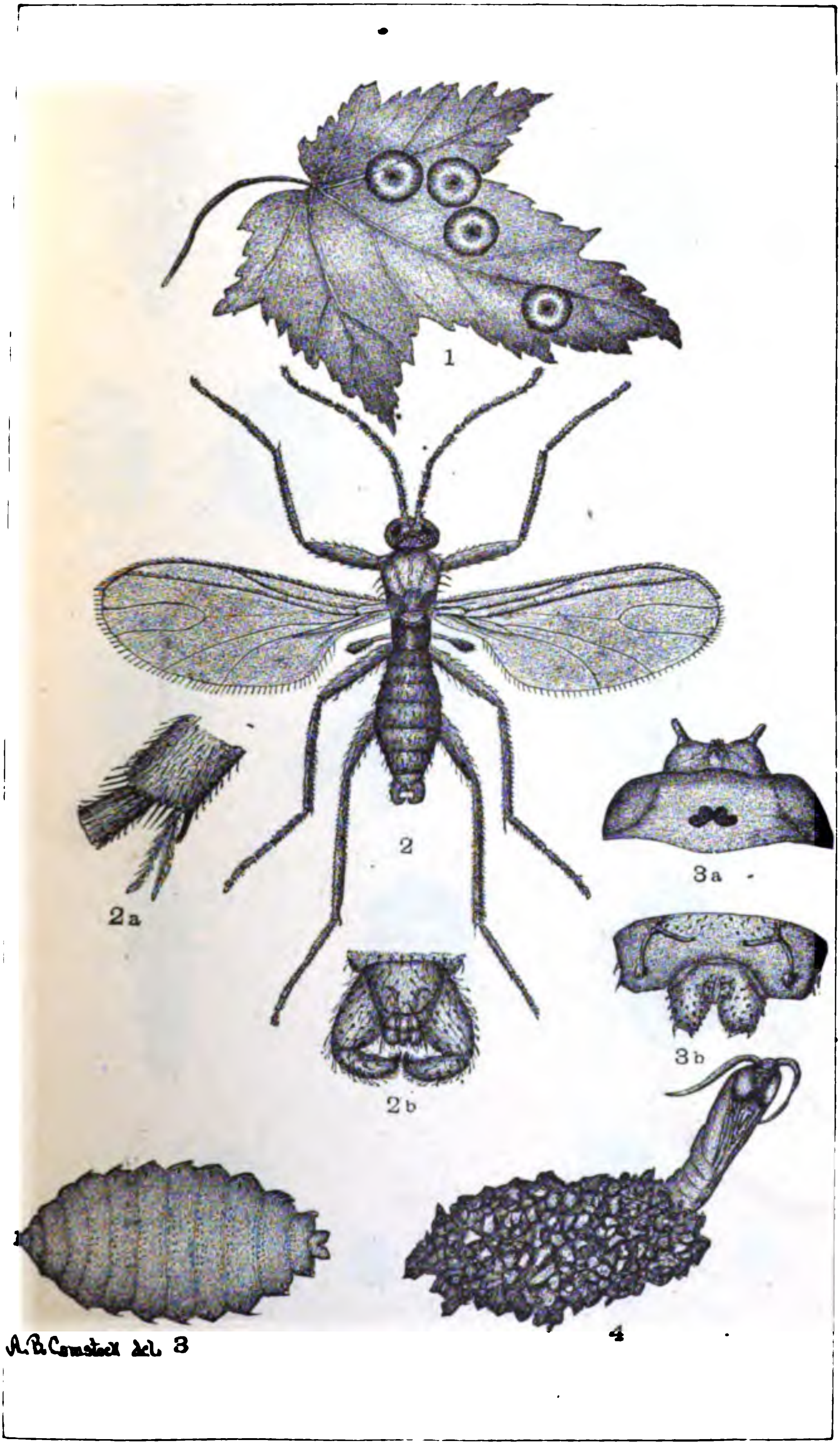
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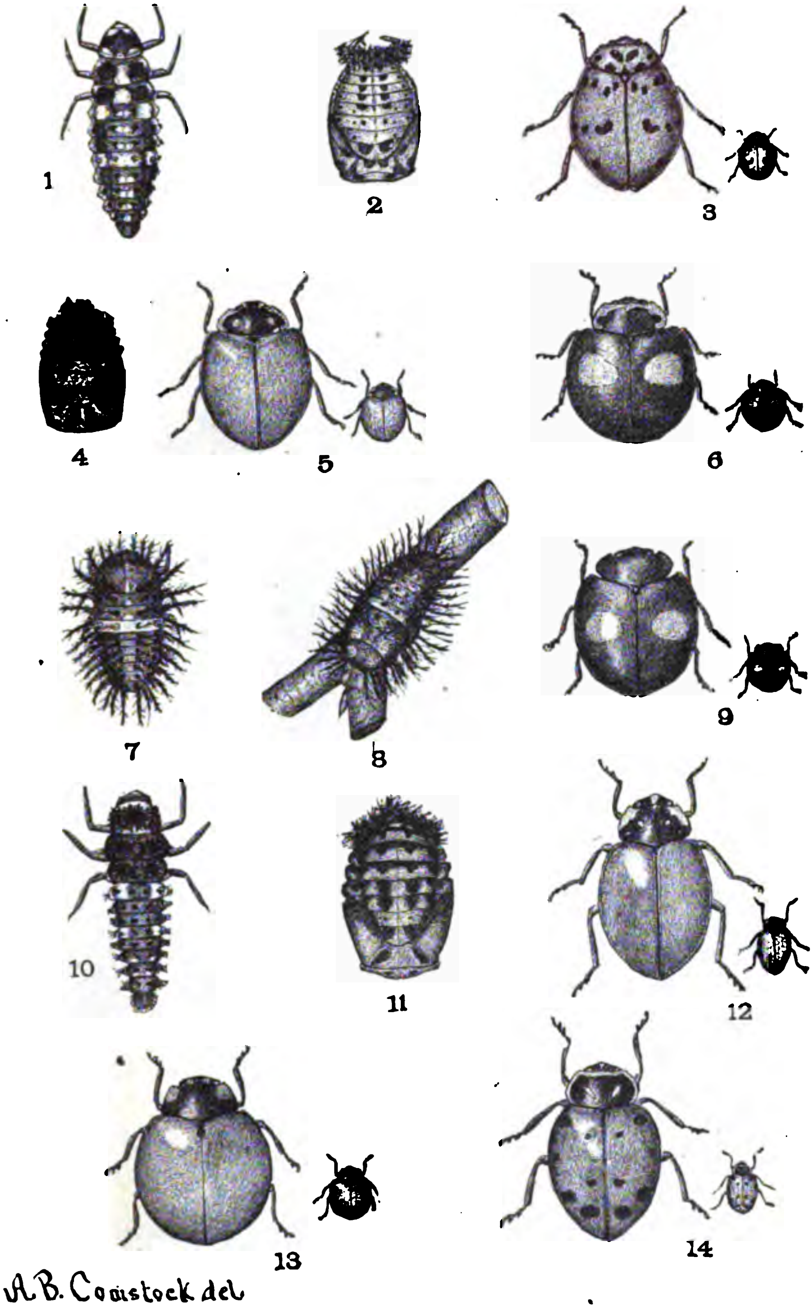
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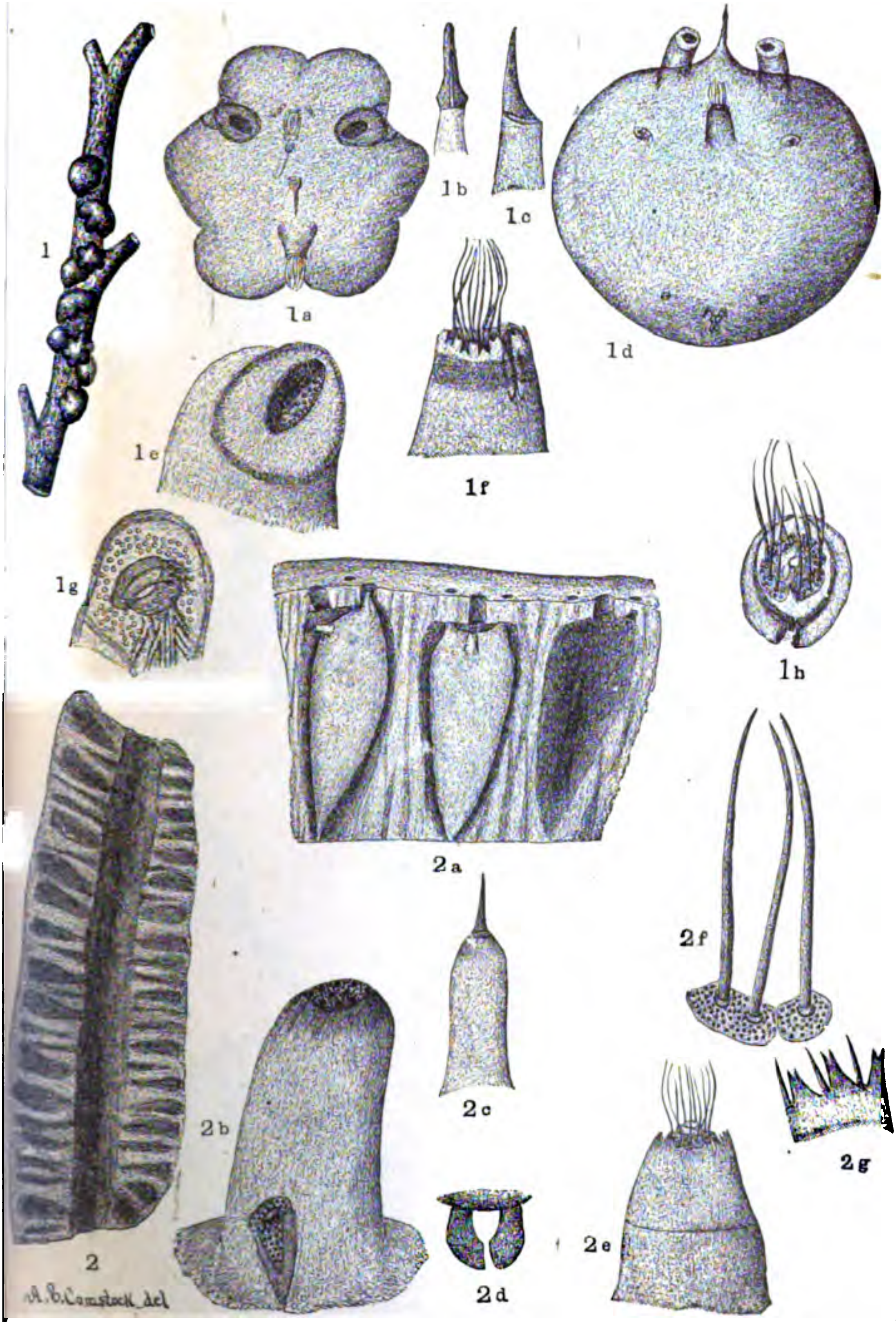
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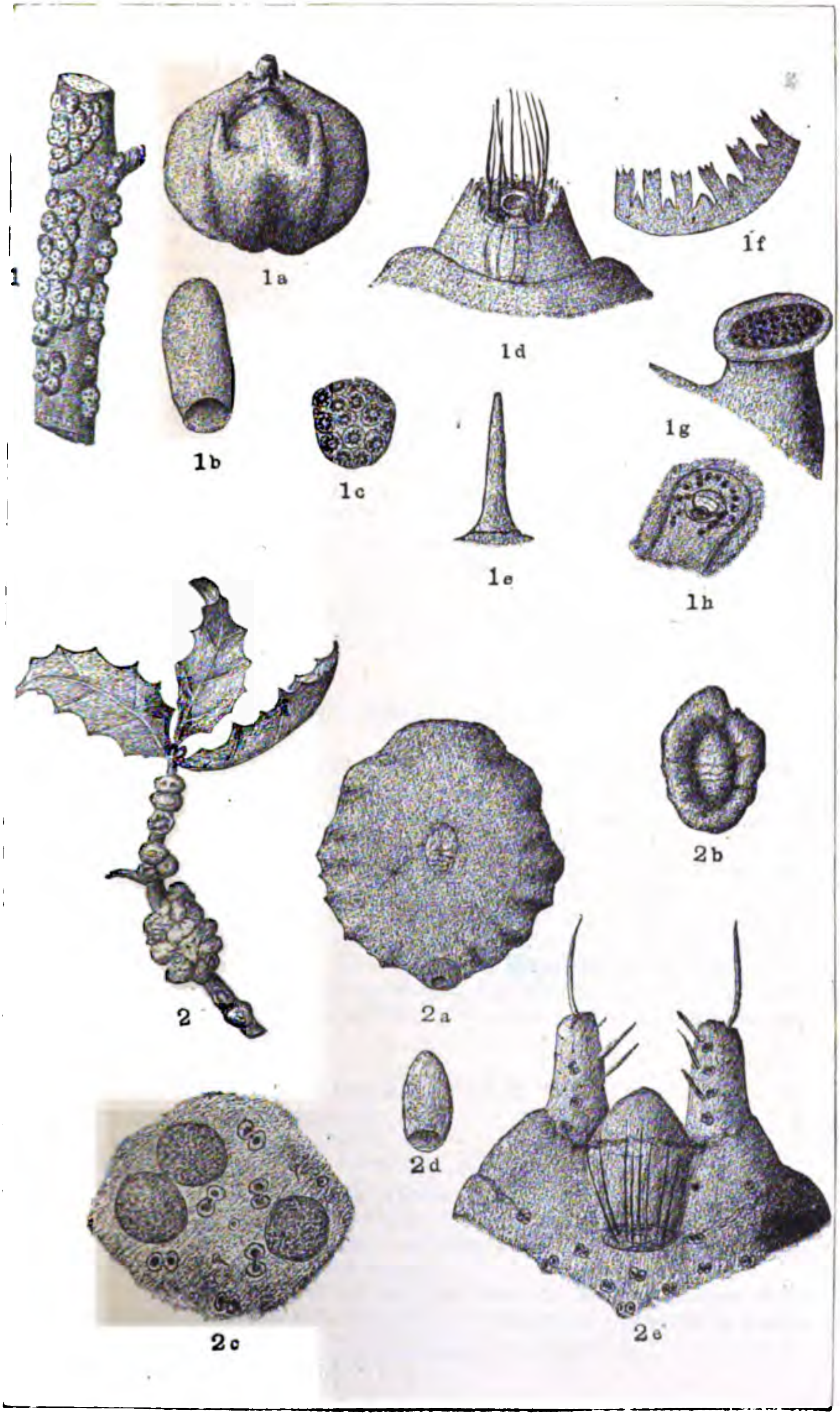
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refrained from patenting his "bamboo extension." It may, therefore, be attached to any other force-pump, and furnished with any other spray-tip than those mentioned above, if it is found desirable to do so.

LAC INSECTS.

It is now more than one hundred years since *Carteria lacca*, the insect which produces the lac of commerce, was first described.* Since that time many articles have been written respecting it. Owing to the importance in the industrial arts of shellac and the lac dyes, the origin of these substances is discussed in nearly all of the larger cyclopedias; and the list of the memoirs on this subject in the scientific journals is a long one. Notwithstanding this, an examination which I have made of the matter convinces me that the subject is not yet well understood.

I was led to study this insect by the fact that I have met with two other species of Lac insects which are as yet undescribed. The result of this study shows that although the two new Lac insects are American they are congeneric with the Asiatic species.

The opportunity of comparing three species of this important genus has enabled me to make some interesting observations, but owing to lack of time I can now give only a general statement of the results of my studies. I am led to make this statement now, as the knowledge of the fact that true Lac insects occur in this country may prove of economic importance.

The genus *Carteria* was established by Signoret† for the Lac insect of commerce. The two undescribed Lac insects agree with this one in the following characters:

Genus CARTERIA Signoret.

Body of the adult female sac-like in form, with no legs, and imbedded in a mass of the substance known as lac. The caudal end of the body is furnished with three prominent tubercles; one, the largest, consists of the caudal segment of the body and is terminated by the anal ring; each of the others bears at its distal extremity a perforated plate, presumably the organ through which the lac is excreted; near the base of each of the lac tubes is a large spiracle. In the triangular space inclosed by the three tubercles described is a fourth tubercle which bears a very prominent spine-like organ. The anal ring consists of several plates, which are perforated by many openings; the anal ring bears ten hairs, and is at least partially surrounded by a series of toothed plates and spines.

CARTERIA LACCA (Kerr). Plate XIX, Fig. 2, 2*g*.

Coccus lacca Kerr. Phil. Trans., 1781, 374.
Coccus ficus Fabr. Mantissa, 1787, II, 319.
Carteria lacca (Kerr) Signoret. Essai, 1874, 101.

From a quantity of commercial stick-lac purchased in New York I obtained specimens of an insect which I have no doubt is the *Coccus* (*Carteria*) *lacca* of authors. From these specimens the following description and accompanying figures were drawn.

The best specimens of this lac is in the form of an incrustation from one-fourth inch to three-eighths inch in thickness upon small twigs

* James Kerr, Philosophical Transactions, 1781, 384.
† Essai, 1874, p. 101.

(Plate XIX, Fig. 2). This incrustation is filled with elongated cells. The longer axis of each cell is at right angles to the twig, and in each case the end of the cell next the twig is small, while the outer end is considerably enlarged. In well-preserved specimens three tubular openings may be seen extending from the outer end of each cell through the incrustation to the open air, and in each cell may be found the shriveled remains of an insect, which, when alive, evidently nearly filled the cell cell and determined its form.

By soaking the insects in water they may be made to swell out, and thus the natural form of the body be ascertained. This is represented at Fig. 2*a*. The cephalic end is small, and, in addition to mouth parts of the form characteristic of the Coccidæ, is furnished with a pair of fleshy appendages, Fig. 2*d*. The body enlarges gradually toward the caudal end. This end is of the peculiar form described above in the characterization of the genus. In a word, the shape of the body is that of a jug with three necks and a pointed bottom, the cephalic end forming the bottom. Each of the neck-like prolongations of this jug-shaped body fits into one of the three tubular openings of the cell. One of these openings is larger than the others; this is the one occupied by the anal tubercle.

The anal tubercle consists of the whole of the last segment of the body, and a part of the penultimate segment, Fig. 2*e*. The anal ring bears ten hairs and consists of several plates, Fig. 2*f*. The hairs of the anal ring are spine-like. Each is curved outward near the middle of its length, and each one is hollow and situated over a large opening in the plate which bears it. There are also many smaller openings distributed evenly over the surface of the plates.

There is a fringe of notched plates and spines on that side of the segment which is toward the lac tubes, Figs. 2*e* and 2*g*. I have been unable to trace any tracheæ extending to the numerous openings with which the lac tubes are furnished; but the distal extremity of each tubercle contains many tubular glands, which in some instances I have traced to these openings. The structure of these organs is represented at Fig. 2*b*.

There are four spiracles, a large one at the base of each of the lac tubercles, and a pair of smaller ones near the head-end of the body. Evidently the air must have free access to the cell, else these spiracles would be of little use. The air probably enters through the opening made by the caudal segment. In all the specimens which I have examined, in which the insect was unbroken, the lac tubes were within the corresponding tubular openings of the cell, but in no instance have I found the anal tubercle in the third opening. In each case it had been withdrawn into the cell, and occupied a position just below the anal opening, Fig. 2*a*. This withdrawal may be due to the shrinking of the body after death; but the fact that it is always the anal tubercle that is withdrawn, and not either of the others, indicates that during life this tubercle cannot be permanently fixed in its opening. The withdrawal of the anal tubercle at intervals would admit the air to the cell, and thus provide for respiration. The peculiar bending of the hairs of the anal ring is such as would facilitate the pushing of the anal tubercle into the opening after it had been withdrawn.

I have been unable to ascertain the function of the large spine. As these insects are viviparous the spine cannot be an ovipositor. The only author who I find makes mention of it is Gernet,* who simply

* Einiges ueber *Coccus lacca* und dessen Parasiten, *Moskau*, 1863.

states that there exists midway between the three tubercles a small, thickened spine, which appears to be nothing else than an enlarged bristle of the last, or next to the last, segment of the abdomen. He also states that sometimes there are two of these spines, and figures a female with two. This is undoubtedly an error.

The fullest account which has been published respecting this insect is that of H. J. Carter,* in whose honor the genus was named. Mr. Carter's memoir is a very important one, but he has fell into some errors. From his account it is evident that the insect, like many others of the Coccidæ, excretes considerable masses of apparently wooly matter. This matter is probably excreted by spinnerets upon each of the three caudal tubercles, and projects from each of the three openings in the cell. The remains of these threads of excretion may sometimes be seen in the stick-lac as it reaches us, but the greater part of them are brushed or blown away. Carter believed these threads to be external tracheæ, and he figured internal tracheæ communicating with them. He even represents "tufts of tracheæ" projecting from the anus. He appears to have overlooked entirely the true spiracles, and believed the paired tubercles to be simply for respiration. No mention is made of the spine, and in the description of the male the caudal threads of excretion are spoken of as tracheæ.

CARTERIA LARREÆ, n. sp. (Plate XX, Figs. 1–1k.)

The Creosote plant (*Larrea mexicana*) is a shrub growing, from 4 to 6 feet high, very abundantly in certain regions in the southwestern portion of the United States and in Mexico. It is said to form—

a dense and almost impassable scrub, particularly on the borders of the Colorado desert, where its luxuriant growth puts a stop to the drifting sand. It is a sure sign of a sterile soil, for wherever it flourishes little else can be found, and although it gives the scenery a beautiful, verdant appearance, its strong, creosote-like odor renders it so repulsive that no animal will touch it. Moreover, as it can scarcely be made to burn, it is useless even for the purpose of fuel. The resinous matter to which the odor is due abounds in all parts of the plant. The Pimos Indians collect and form it into balls, which they kick before them as they journey from one point to the other of their trail.†

This extract gives, in a few words, what was until recently the accepted belief respecting American lac. But in April, 1880, Mr. J. M. Stillman presented to the California Academy of Sciences‡ a very able and important paper on this subject, in which he showed that the so-called resinous exudation of the creosote plant was apparently identical with the gum-lac from India. Mr. Stillman also gave very cogent chemical and physical reasons for believing that in each case the lac is excreted by the insects found in it instead of being simply an exudation of the plant caused by the punctures of these insects, as is stated in nearly all of the writings on the subject. The presence of the large and complicated excreting organs, which I have termed lac tubes in each of the species described in this paper, confirms this conclusion.

A study of the insect which produces the American lac shows that it is specifically distinct from *Carteria lacca*. I therefore propose the name *C. larreæ* for it. In all the specimens which I have seen, the incrustation of lac is not as thick as that produced by *C. lacca*, being rarely more than one-eighth of an inch in thickness. And the masses excreted

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*Annals and Magazine of Natural History, 1861, p.p 1–10.
†A. Smith, in the Treasury of Botany.
‡See American Naturalist, Vol. XIV, p. 782.

by the different individuals are not crowded together so compactly as in the Indian species, but preserve a more or less globular form. (See Plate XX, Fig. 1.) In the case of isolated masses there is a tendency to a six-lobed condition.

This species is the smallest of the three known Lac insects, the adult female being but little more than 2^{mm} (.08 inch) in diameter. The body is nearly globular in outline, with, however, prominent lac tubes and anal tubercle. The caudal spiracles are also prominent. Fig. 1*a* represents an individual from which the greater part of the lac has been dissolved. A specimen treated in this way served to show the general form of the body. The structure of the different organs was studied upon specimens which had been boiled in caustic potash, and from which in this way all the excretion had been removed. Fig. 1*d* represents the anal tubercle with the anal ring and fringe. Fig. 1*f* shows a part of the fringe enlarged. One of the lac tubes with its perforated plate is represented at Fig. 1*g*, the corresponding spiracle at Fig. 1*h*, and the spine at Fig 1*e*. Scattered over the surface of the body are groups of organs which appear like the compound spinnerets of the Diaspinæ. One of these groups is represented at Fig. 1*c*. The male of this species was found, but in too mutilated condition for detailed description. A shrivelled balsam-mounted specimen showed the body, including the style, to be 1^{mm} ($\frac{1}{25}$ inch) in length. The length of the style is two-sevenths of the whole length of the body. On each side of the style there is a pair of hairs which resemble those of *Rhizococcus araucariæ*. (See Agricultural Report, 1880, Plate X, Fig. 1*b*.) The antennæ and wings are normal. The sac of the male is egg-shaped. Only empty ones were observed, each of which had an opening at one end from which the male doubtless emerged (Fig. 1*d*). The sac is about 1.5^{mm} (.06 inch) in length. They occur in masses.

CARTERIA MEXICANA, n. sp. (Plate XIX, Figs. 1–1*h*.

On looking over the collection of coccids in the Museum of Comparative Zoology, which Dr. Hagen kindly placed at my disposal, I found a twig of Mimosa from Tampico, Mex., which bore a number of globular or more or less stellate masses of what proved on further examination to be lac. Each of these masses contained an insect. This insect proves to belong to the same genus as the two Lac insects already described, but is specifically distinct from either.

As the specimen which I have is a very small twig, which bore only about fifteen insects, it may not represent well the usual appearance of this lac. On this twig the lumps of lac excreted by the individual insects occur singly or are but slightly massed. Each lump is six-lobed at its base; this is more marked in the case of the immature specimens than with the adults (Plate XIX, Fig. 1). This stellate form of the lump of lac is due to a similar form of the body of the insect which excretes it. Fig. 1*a* represents an immature female seen from above, which is approximately from the caudal end. The natural attitude of the insect is, like that of the other Lac insects, with its cephalic end next to the plant and the caudal end farthest from it. The specimen from which the figure was drawn had been boiled in caustic potash, and thus rendered transparent. The mouth-parts and antennæ are represented as showing through the body; the other organs figured are on the caudo-dorsal surface of the body. The anal tubercle and the spine are well developed. The perforated plates, the openings of the lac glands, are also well developed, but are sessile. This is the most obvious difference between this stage and the adult. Closely associated with each perforated plate is a large spiracle; these being on the sides of the body are shown only in profile.

The form of the body of an adult female is represented at Fig. 1*d*. In this stage the lac tubes are well developed, as shown in the figure. The extremity of a single lac tube, with its perforated plate, is represented at Fig. 1*e*. Four spiracles are present, one on each side of the body laterad of the anal tubercle, and a pair near the mouth-parts (Fig. 1 *d*). One of the caudal spiracles is represented at Fig. 1*g*. As in the other species of this genus, the opening of the spiracle is surrounded in each case with a number of spinnerets. The anal ring (Fig. 1*h*) consists of four plates, two of which bear three spines each, and two two spines each. Surrounding the anal ring is a pair of chitinous pieces forming a ring. This second ring I have observed in many genera of this family, and I believe the number and shape of the plates of which it is composed will be found to afford generic characters. These two rings are partially surrounded by a fringe of plates and teeth (Fig 1*f*).

A NEW WAX INSECT.

In the old collection of the Department of Agriculture I found several twigs of oak bearing large masses of bright, yellow, and nearly spherical, sac-like bodies which appear to be largely composed of wax. Each of the sac-like bodies contained the shriveled remains of an insect which evidently excreted it, and which proves to belong to an undescribed genus of the *Coccinæ*. The twigs of oak belong to two species, native of Arizona, *Quercus oblongifolia* and *Quercus undulata*, variety *Wrightii*. I have also specimens of the same insect from the Museum of Comparative Zoology infesting what is probably *Quercus agrifolia*, and which were collected in California by Osten Sacken.

Judging from the specimens before me, this insect occurs in sufficiently great numbers to be of economic importance if the excretion can be utilized as is the excretion of an allied insect which produces the true white wax of commerce. The matter is now being investigated by the chemist of the Cornell University Experiment Station, and will probably be discussed in the next report of that institution.

I submit the following characterization of the genus to which this insect belongs:

CEROCOCCUS, new genus.

Adult female apodus; body covered with a layer of waxy excretion, which forms a continuous sheet, not composed of a number of plates more or less closely united, as in Ceroplastes. The excretion forms a complete sac about the body of the insect. At the caudal end of this sac there is an opening; and on the dorsal part near the center the larval skin is imbedded but plainly visible. The adult female is provided with spinnerets of two kinds, which may be designated as double pores, and simple pores, respectively. Anal segment with the two caudal lobes characteristic of the Coccinæ; anal ring with eight spines; anal plate of a single piece, and situated dorso-caudad of anal ring. Mentum of two segments.

CEROCOCCUS QUERCUS, n. sp. (Plate XX, Figs. 2–2*e*.)

Sac of female.—The sac in which the body is inclosed is bright yellow in color, elliptical in outline, very convex above. The lateral margin bears a row of tubercles which evidently correspond to the segments of the body. Length 6^{mm} (.24 inch), width 5^{mm} (.2 inch). Usually these sacs are more or less massed around the twig. (Plate XX, Fig. 2.)

The form of the sac of the immature female is represented by Fig. 2*b*. The larval skin occupies the center of the dorsal surface, and the excretion forms a thick ring around this skin.

Female.—The body of the female is elliptical in outline, with neither legs nor antennæ. The caudal end of the body is terminated by two prominent lobes (Fig. 2*e*), each of which bears a long terminal bristle and several shorter ones. The anal ring is situated in a deep depression, from which the spines of the ring hardly project. This is represented in optical section in Fig. 2*e*. Dorso-caudad of the anal ring, near the opening of the depression in which this ring is situated, is the anal plate. The edge of it is represented as a line extending from the base of one lobe to the other in Fig. 2*e*. Scattered over the surface of the body are a large number of paired pores. These are represented in Figs. 2*e* and 2*c*. A few single pores occur also. Near the caudal end of the body there are several round bodies, which I have termed the madreporiform bodies (Fig. 2*e*).

Sac of male.—The sac of the male is oval, with an opening at one end from which the male emerged (Fig. 2*d*). The male was not observed.

NOTE ON THE STRUCTURE OF MEALY BUGS.

In *Dactylopius*, and presumably in other genera of the Coccinæ, the opening of the oviduct is distinct from that of the posterior end of the alimentary canal, being on the ventral side between the sixth and seventh abdominal segments. I have watched a female during the act of ovipositing, so there is no doubt respecting this matter. Consequently the expression *ano-genital ring*, which has been applied by authors to the ring of hairs and spinnerets at the caudal end of the body, is not correct. The term anal ring is the appropriate one.

We have also observed in *Dactylopius* a pair of openings on the dorsal side of the sixth abdominal segment, which are evidently homologous with the honey tubes of the Aphididæ. A female mealy-bug was gently rubbed near the caudal end of the body, when suddenly there appeared two drops of a clear fluid, resembling in appearance the honey-dew of plant-lice. This experiment was repeated many times and with many specimens. Mr. Pergande assures me that he has observed a similar excretion from a pair of openings on the cephalic margin of the first thoracic segment also.

REPORT OF THE SUPERINTENDENT OF GARDENS AND GROUNDS.

SIR: I have the honor to submit the following notes on matters pertaining to the duties and objects of this division:

THRIPS ON GRAPES.

For several years the foreign grape vines under glass have been severely injured by thrips. All efforts and expedients to eradicate them have been but partially effective. During the early part of the growing season the insects could be kept in check, either by fumigations with tobacco, syringing with water in which tobacco had been steeped, or spraying the foliage with a weak solution of quassia chips; but when the fruit approached maturing, or rather when it commenced to color, these applications had to be discontinued, so that the fruit would not be rendered unfit for use; then the insects would increase rapidly and injure the foliage so that the fruit became comparatively worthless. Further than this, the annual destruction of the foliage before the growth was matured was gradually weakening the plants, so that their utter destruction was only a question of time unless some means could be adopted to annihilate the insects.

This means has been adopted. It consists simply in covering the floor of the house with tobacco-stems, the refuse of cigar manufactories; this mulching proves quite effectual, as, since the application was made, no thrips have been seen, and, although the insects had spread considerably before the tobacco-stems were used, they rapidly disappeared after the application.

It is perhaps worthy of remark that, since using the tobacco mulching, no sign of mildew has been observed on the grapes. Of course it is known that mildew may be avoided by strict attention to ventilation, but in the early part of the season, when the ventilators have to be closed at night and opened during the morning, it is not always practicable to prevent cold currents of air from striking some portion of the foliage, a circumstance which will induce fungus growths on the leaves; not the slightest indication of mildew has been observed since the tobacco-stems were sprinkled over the floor.

Letters are frequently referred to this Division containing inquiries regarding the adaptability of various tropical and semi-tropical plants for cultivation in Southern Florida and in Southern California. Many of the plants about which information is sought are probably too tropical in their nature to succeed well in any part of the United States, but, when we take into consideration the almost tropical character of the indigenous vegetation of Southern Florida, it may not be well to pronounce too decidedly, in advance of practical tests, in regard to the successful culture of any tropical product.

The following notes on some of the plants which have been the subjects of special inquiry are submitted as information to those who are interested in them, and also as they may be available for future reference:

THE TAMARIND TREE (*Tamarindus indica*).

This plant is a native of the East and West Indies, Arabia, and Egypt. In general appearance it somewhat resembles the yellow-locust tree, but the branches are more of a spreading character; its pinnate leaves are sensitive to cold, closing up like the well-known sensitive plant of the gardens. It is sometimes cultivated in warm conservatories, where it frequently produces its fragrant flowers and occasionally ripens its fruit.

There are two very distinct varieties of the tamarind; the kind indigenous in the East Indies has larger fruits than that cultivated in the West Indies. The East India tamarind fruit is from 4 to 6 inches in length, and consists of a brown, brittle shell, containing from 6 to 10 seeds enveloped in a soft, acid pulp, the whole being held together by a thin membranous covering. They are darker in color, and have a larger and sweeter pulp than the West Indian variety, and can be preserved without any addition of sugar or sirup. The West India tamarind has pods from 2 to 4 inches in length, containing from 2 to 4 seeds in each. The outer pericarp, or shell, having been removed, they are placed in casks in layers with sugar; when packed, the interstices are filled by pouring boiling sirup into the cask, which is closed up after the contents have cooled.

The West India variety is considered to be hardier than that cultivated in the East, but the fruit is not so highly prized. But none of them will grow in climates where frosts occur.

THE CHERIMOYER (*Anona cherimolia*).

The Cherimoyer or soft-fruited custard apple is a medium sized tree, a native of Peru, New Grenada, and other parts of South America. It is cultivated to some extent in these and other tropical regions for the sake of its fruits, which are highly esteemed by the natives of those countries. The fruit is large, from 2 to 4 pounds in weight. The flesh is sweet, slightly fragrant, and about the consistency of a custard.

THE SWEET SOP (*Anona squammosa*).

This tree is cultivated both in the East and West Indies for the sake of its fruit, which is called the Sweet sop. It is an egg-shaped, fleshy fruit, covered with a thin tubercular coat; it has a thick rind which incloses a soft, sweet pulp of a peculiar flavor, not much relished by those unaccustomed to its use, but it is highly esteemed by the natives.

The leaves of the tree have a disagreeable odor, and the seeds contain an acrid principle which is fatal to insects; and a powder made from the seeds is used for the destruction of insects on animals.

The BULLOCK'S HEART APPLE (*Anona reticulata*) and the ALLIGATOR APPLE (*Anona palustris*) are sometimes mentioned among fruits worthy of culture, but compared with our cultivated fruits they are unworthy of notice.

BROMELIA SYLVESTRIS AND BROMELIA KARATAS.

These plants belong to the pineapple family, and contain a fine, tough fiber in their leaves, which is known in the West Indies as silk-grass; in Central America it is known as pita, and in Mexico as istle, and sometimes as ixtle fiber. The silky fibers are held together by gummy matter which is capable of being dissolved, after which the fibers are easily separated. The primitive mode of preparing this fiber is by steeping, beating, and scraping the leaf in a green state. After the removal of the glutinous matter it is combed out and rubbed by hand until the fibers are separated. When the plant is young the fibers are fine and white; in older plants it is longer and coarser. The broken leaves are worked into a good paper fiber. The fiber from these plants is known in British Guiana as corawa fiber.

The Bromelias are short-stemmed plants, having a densely packed head of stiff leaves which are from 3 to 6 feet in length and 2 to 3 inches in width. They are sometimes used for hedges, for which they are well adapted. They are cultivated in a manner similar to that adopted with pineapples in Florida, and are propagated mainly from off-sets or suckers from the stem.

THE PARAGUAY TEA TREE (*Ilex paraguayensis*).

This is a large growing tree, a native of South America, where its leaves are collected and used in infusion as an article of food, under the name of maté.

In rich soils the tree will reach to a height of from 70 to 90 feet; from the accounts of some it is said to be confined to mountain slopes, never appearing on table-lands nor on the broad plains which skirt the river beds, while others mention that the tree is plentiful in all the moist valleys that branch out of the extensive chain of mountains that divide the waters of the Parana and Paraguay Rivers. It is well understood, however, that the leaves of various species of *Ilex* are collected in common by the natives, and that the trees are found over a widely-extended range of country and in a diversity of soils and situations.

The "*Herva de Palmeira*" of the Brazilians is produced from different species of *Ilex* which grow on the banks of the river Uruguay, and the leaves are considered to be equal in value as a beverage to that of the *maté* or *herva yerba* of Paraguay.

The tea as prepared in Brazil is a mixture of the leaves of two very distinct species, the *Ilex gigantea*, which has large leaves and yields the article known as *herva mausa*, or mild maté, and the *Ilex Humboldtiana*, yielding *herva brava*, or wild maté.

The *Herva de Palmeira* is considered equal to best Paraguay tea; the *mausa* and *brava* are considered inferior, although when mixed in certain proportions a maté equal to the genuine Paraguay yerba is produced.

For the preparation of maté proper the leaves are dried, or rather roasted, in cast-iron pans set in brickwork and heated by fires underneath; when the leaves are sufficiently heated they are pounded in stamping-mills worked by water or steam power until reduced to powder, and then packed in bags by means of presses.

There are three qualities or sorts of yerba known in the South American markets. The best is said to be prepared from the young leaves when they are about half expanded from the bud, called *caa-cuys;* the second consists of the full-grown leaves, carefully picked and separated from twigs, and frequently the midrib and veins of the leaves are removed; this is called *caa-mira;* the third is the *caa-guaza*, or Yerva de Palos, made from older leaves, carelessly broken up with the small branches and leaf-stalks, all of which undergo the roasting and pounding process together.

The leaves are also collected and dried in a similar manner to that adopted in the preparation of Chinese tea. This is called maté in leaf, and is prepared for use by infusion and taken with milk and sugar the same as ordinary tea. Maté in powder is also prepared by infusion, by putting into a small vessel about an ounce of the powder and pouring boiling water over it; as the fine dust does not fall to the bottom but remains suspended in the water, the maté is taken by means of a sucker, that is, a tube terminating in a small hollow ball, pierced with very fine holes.

Maté contains theine, the same active principle as tea and coffee, but it is not possessed of their volatile and empyreumatic oils; it contains less essential oil, and is therefore not so exciting as coffee or tea; it contains more resin than coffee, less than tea; it is therefore more diuretic than coffee, and is as stimulating as tea. Chemical analyses show that it contains nearly double the quantity of theine that the same weight of grains of coffee contains, and about the same quantity as tea leaves. The Brazilians recommend maté as a nourishing, warm, aromatic, stimulating diuretic and very cheap beverage; its extreme cheapness is a guarantee of its genuineness, as it is not worth adulterating.

The trees furnishing these leaves are not known to be cultivated anywhere. The natural forests seem to be able, so far, to supply the consumptive demands. The Department has had repeated inquiries regarding the best climatic conditions for the culture of the plants, and how plants may be obtained; to the former inquiry, it would seem to require a strictly tropical climate, and as to propagation, no satisfactory information has been obtained.

THE CHOCOLATE-PLANT (*Theobroma cacao*).

This is a small tree, reaching from 15 to 20 feet in height, a native of tropical America, where it is cultivated to a large extent for the sake of its fruits, which contain the seeds called cacao-seeds. It is also cultivated in some of the West India Islands and in other tropical countries.

Young plants are raised from seeds which are sown in nursery rows, and transplanted when two years old. Rich bottom-lands are preferred for starting a plantation; the plants are placed about 15 feet apart and shaded by bananas and similar fast-growing plants. They come well into bearing when five or six years old, and in well managed plantations receive careful culture so as to thoroughly repress all other growths. It is said that there are several varieties in cultivation, some being better fitted for hilly situations, but the best seeds are from plants growing in rich, low-lying lands. It is probable that some of the hardier varieties would flourish in the warmer portions of the Southern States, but it may be doubted as proving a profitable culture.

The fruits of the cacao very much resemble small cucumbers; they vary in length from 6 to 10 inches and from 3 to 5 inches in width. Each fruit contains from 50 to 100 seeds, imbedded in pulp; these seeds furnish the cacao of commerce.

The fruits remain green until within a short time of ripening; afterwards they rapidly change to a yellow color, when they are ready to be gathered. As they become dry the outside pod shrivels and changes to a brown color; they are then split open, the seeds taken out, cleaned from the pulpy matter adhering to them, and subjected to a process of fermentation for several days, which improves their color; they are then dried in the sun for some time, and afterwards packed for shipping.

TURMERIC.

This substance is produced by the *Curcuma longa*, a low-growing herbaceous plant, a native of the East Indies, but widely spread and cultivated over the West Indies, Central America, and other warm countries. The culture of the plant is similar to that of the arrowroot. A rich soil is necessary to produce the best root-stalks. The old roots only yield turmeric; the young tubers furnish a kind of arrowroot. The plants are increased by division; they are set out in rows and cultivated like potatoes. It is an easily managed crop so far as culture is concerned.

The article turmeric is prepared by reducing the roots to powder, which acquires a fine yellow color. It is used for various purposes, such as an ingredient in cookery dishes, as chemical tests for the presence of alkalies, and to some extent in medicine.

THE SICILIAN SUMAC (*Rhus coriaria*).

This small tree is a native of Southern Europe, where it is cultivated for the tannin contained in its leaves, which furnish the sumac of commerce. It is largely grown in Sicily, near Palermo and Alcamo, that grown near the former place being considered of superior quality to that grown on the south or eastern coasts. To grow sumac in perfection requires a soil of only medium fertility; it is found that a very luxuriant growth is produced at the expense of the tannin principle; an exposure to sun on a southern slope is also favorable to an increase of tannin.

The planting of sumac is effected in a manner very similar to that adopted by farmers in planting potatoes; furrows are drawn about 3 feet apart, in which pieces of the running roots of the plant are deposited at regular spaces about 2 feet apart, and covered by turning a furrow over them with the plow. This planting takes place in early spring, and for the first year the only care is to keep the ground free from weeds. In the fall the young plants are headed down—cutting them back to near the surface of the ground; this is done for the purpose of increasing the number of shoots for the growth of the ensuing year. In some plantations this heading back is continued to the second year's growth, under the belief that it increases the value of the leaves.

The harvesting process is very similar to that adopted in making hay from grass; the branches are mown over and carefully cured by drying in the sun. After being thoroughly dried the leaves are threshed from the branches; they are then collected and ground to powder by a system of millstones set on edge, running on a smooth, hard surface, on which the leaves are placed. Various methods are adopted in grinding, the desideratum being to produce a fine powder. After being cleaned of small portions of branches by sifting it is ready for market.

A plantation is not expected to remain profitable for a longer period than 10 years. The average yield is 2,600 pounds per acre.

THE JAPAN VARNISH TREE (*Rhus vernicifera*).

This plant yields, in part at least, the varnish used for lacquer-work in Japan. It is a low growing tree, seldom exceeding 20 feet in height, and is sufficiently hardy to stand the climates over a large portion of the United States. The varnish is collected from incisions made in the tree during the heat of summer; at first it is of a milky-white color, but turns black by exposure to the air. The preparation of the article to be varnished is an important process of the art of lacquering. It has been said that the modern lacquer is of an inferior quality to that of the ancient, and that the Japanese have lost the secret of its preparation; to this it has been replied that less care is now given to the work, and that when the articles are prepared by repeated coatings of lime, gum, and soft, coarse clay, first allowed to harden and then scraped and rubbed off, until the surface is rendered exceedingly hard and smooth, and afterwards receiving as many as fifty coats of the varnish, each coat being allowed to dry in a close, dark room, and severely rubbed down before receiving the next coating, that the surface becomes perfect and as durable as the older specimens of this kind of work.

THE LEE-CHEE TREE (*Nephelium litchi*).

This tree is cultivated in orchards in Southern China for its fruits, which are highly esteemed in that country, and in a dried state are exported in considerable quantities.

The tree grows to a height of from 25 to 30 feet. It may be cultivated in many of our Southern States if found to be profitable. The fruits occasionally appear among other articles of import, but it is believed that the culture would not be remunerative; it is also known as the Lichi, or Litschi. The fruits are produced in small bunches; the single berries are nearly round, about one inch in diameter, and covered with small, wart-like protuberances. When ripe they are of a reddish color, and contain a pulp of the consistence of honey, and of a very sweet, pleasant flavor. As seen in commerce, in the dried state, they present a wrinkled appearance, are dark in color, and somewhat resemble prunes.

An allied species, *Nephelium longanum*, is known in China as the longan tree. It is also subjected to cultivation in that country. The fruits are much like those of the lee-chee, only they are smooth, and have a very tender skin which incloses a thin layer of semi-transparent pulp which has a pleasant, subacid flavor, and to which the Chinese ascribe medicinal qualities.

THE SAGO PALMS (*Sagus rumphii* and *Sagus lævis*).

These palms are natives of the islands of the Indian Archipelago, and yield the palmaceous starch called sago. The first mentioned is known as the prickly sago palm; it forms a tree 30 to 40 feet in height, the leaf-stalks being armed with sharp spines from half an inch to an inch in length. The second mentioned species is spineless, and is called the spineless sago palm; this grows somewhat taller than the other and furnishes the largest portion of the sago of commerce. These plants thrive well only in marshy or even muddy soils, where there is constant water about their roots; they receive nothing of what might be termed cultivation, and a plantation, when once established, may be maintained for an indefinite period, as they throw out lateral shoots, which grow up and take the place of the older trunks, which are removed for the sake of the starch.

The time for collecting the sago is immediately after the flower-spike makes its appearance on the plant, which generally occurs when the tree is 12 or 14 years old. In order to procure it the tree is felled and the trunk cut into pieces about 6 feet in length, which are split open and the pith taken out; this pith is pounded to a coarse powder and thrown into water, which is afterwards drained off from the pulpy mass, and the starch is removed with the water. On being allowed to stand undisturbed for a short time the farina subsides and the water is removed from it, and the article is purified by successive washings with pure water. This is the sago meal, from which is manufactured the pearl sago of commerce.

An ordinary sized tree, of 14 years' growth, yields from 600 to 800 pounds of this nutritious matter.

ALOES.

The aloes of commerce are furnished by several species of the aloes family, but mainly by *Aloe vulgaris*, *Aloe spicata*, and *Aloe socotrina.*

The aloes are usually short-stemmed plants, having thick, fleshy leaves; they are easily propagated by side-shoots, or suckers from the roots, and can be cultivated in fields like cabbages.

The most esteemed aloes of commerce is that furnished by *Aloe socotrina*, a native of the island of Socotra, on the south coast of Arabia, in the Indian Ocean. This appears in commerce in pieces having a yellowish or reddish-brown color; occasionally it appears of a lighter color, but becomes darker by exposure to the air. The color of its powder is a golden-yellow, and it has a peculiar but not unpleasant odor, and a bitter, disagreeable taste, with an aromatic flavor. Socotrine aloes is held in high esteem.

Hepatic aloes is considered to be an inferior selection from the socotrine.

Barbadoes aloes is produced in the West Indies from *Aloe vulgaris*, a widely diffused species, extending to Arabia and the African coast. The color of this article is generally dark brown or black, but sometimes it is of a reddish-brown or liver color, or some intermediate shade. It has a dull fracture, and the powder is of a dull, olive-yellow color. It is made by expressing the juice from the leaves, or chopping them and then evaporating their decoction until it has attained such a consistence that it will harden in cooling, when it is poured into vessels and allowed to concrete. Barbadoes aloes is in great demand in veterinary practice.

Cape aloes is the product of *Aloe spicata*, and is from the Cape of Good Hope. It is sometimes called shining aloes. When freshly broken it has a very dark-olive or greenish color, approaching to black. Its odor is strong and disagreeable. When hard it is very brittle and easily powdered, but in very hot weather it becomes soft and tenacious. The quality of the drug depends much upon the method of preparing it. The finest kind is that obtained by exudation and subsequent inspissation in the sun. The plan of bruising and expressing the leaves and boiling down the juice yields an inferior article, as a large portion of the liquor is derived from the mucilaginous juice of the parenchyma. The worst plan is said to be that of boiling the leaves in water and evaporating the decoction.

The bitter, resinous juice from which the drug is prepared is stored up in vessels lying beneath the skin of the leaves. The juice is collected by cutting off the leaves close to the stem and placing them at once into tubs in an upright position, so that the sap may flow freely from the cut surface. The crude juice is then exposed to the sun, where it is gradually evaporated to a proper consistence, and is then poured into vessels, where it hardens into a black, compact mass. Much of the value of the article depends upon the care bestowed upon its preparation for market.

Horse aloes is a very coarse article made from refuse leaves, and is used in veterinary medicine.

THE CLOVE TREE (*Caryophyllus aromaticus*).

This is an evergreen, and attains to a height of from 20 to 25 feet. It is a native of the Molucca Islands, but has been introduced and cultivated very generally throughout the East and West Indies.

In forming a plantation the trees are planted in rows about 16 feet apart, and the soil is kept clean and mellow by cultivation. The cloves of commerce are the unopened flower-buds; these are collected before they expand by beating them down with reeds, and are received on sheets spread for the purpose. They are prepared for market by smoking them brown over a slow, wood fire, and finally drying them fully in the sun. The quality of the clove is greatly influenced by climate, and although they are largely produced in many parts of the world those from the Moluccas are held in the highest esteem.

The best cloves are dark in color, heavy, and strongly fragrant, the ball on top being unbroken, and yielding oil when pressed by the finger-nail. They contain from 17 to 20 per cent. of essential oil, which is extremely pungent, and is specifically heavier than water. When they are newly gathered a certain quantity of oil may be obtained by pressure; the cloves are impaired in value by this operation, but they are mixed with sound samples, where, however, they can be detected by their pale color, shriveled appearance, and lack of flavor.

THE CHINESE TALLOW TREE (*Excœcaria sebifera*).

This tree has been introduced into many semi-tropical climates and has become common in some of the Southern States. The fruit yields a kind of tallow, which is separated from it by steaming; this is effected by placing the fruit in wooden cylinders having numerous holes in the bottom. These are fitted over caldrons of boiling water, which softens the tallow; the mass is then bruised in a mortar; afterwards it is placed in straw mats and the oil squeezed out under heavy pressure, when it soon hardens into a white, brittle, opaque mass. This tallow melts at 104° F., and is composed mainly of tripalmatine, a substance which is saponified by alcoholic potash and produces palmitic acid. It is used for candle-making in China; the candles are coated with insect wax to prevent them from becoming soft in hot weather; they are generally colored red or green, and compare favorably with those made from spermaceti.

An oil is also extracted from the kernels which burns well in lamps; a good black dye is obtained from the leaves; the wood of the tree is very hard and is used by the Chinese for printing-blocks.

The tree is of free growth and will grow in any ordinary arable soil. It is easily raised from seeds and soon reaches to a fruiting condition, so that a plantation of them may be secured in a few years.

THE CHOCHO, OR CHAYOTE ROOT.

These names are given to the root of a climbing plant, indigenous to Mexico, South America, and the West Indies, where it is cultivated for the sake of its edible roots and fruits. The botanical name of the plant is *Sechium edule.* The root is fleshy and large, some specimens weighing 20 pounds; these resemble, both in appearance and eatable qualities, the common yam. It is much used in the West Indies under the name of chocho. It was cultivated by the ancient Aztecs under the name of chayotti, and is now known in Mexico as the chayote root. Samples of starch prepared from the tuber were displayed in the Mexican exhibit at Philadelphia in 1876, accompanied with the following analysis of the root: Water, 71; starch, 20; resinous matter, soluble in water, 0.20; sugar, 0.32; vegetable albumen, 0.43; cellulose, 5.60; extractive matter, tartrate of potash, chloride of sodium, sulphate of lime, and silica, 2.25; loss, 0.20.

Seeds of the *Sechium* sown in spring furnish plants which mature fruit the same season. After the growth of the second year a portion of the tuber can be removed without destroying the plant, an operation which can be repeated for several years, at least in climates where there are no frosts. A plant that produces eatable fruits, with a valuable farinaceous root, seems to be worthy of attention.

THE CORK TREE (*Quercus suber*).

This a native of Southern Europe and Northern Africa. It grows to a height of 40 or 50 feet. It is the great source of the cork of commerce; this substance is the outer bark of the tree, which is of great thickness and elasticity, owing to an extraordinary development of the cellular tissue. The corky bark ultimately cracks and separates from the inner bark, which remains attached to the tree. Both the outer and inner barks abound in tannin, and the former contains a peculiar principle called *suberine* and an acid called *suberic* acid. The cork tree flourishes well south of Virginia; it will stand ordinary winters north of this State, but severe winters injure it considerably, especially when the plants are young. A plant in the grounds of the department was killed during the severe winter of 1880–'81, when the thermometer indicated 18 degrees below zero. It is readily raised from the seeds, which, however, have to receive special care in packing, so that they may retain vitality during the time necessary for transportation from Europe. The trees are usually allowed to grow for sixteen years before the first removal of the bark takes place. The first crop of bark is considered of but little value, except for tanning purposes, being full of cracks and cells. After a period of eight or ten years the bark is again removed, but this is also considered of an inferior quality, and is employed for floats for nets and similar purposes. At the end of ten years or more a third cutting takes place, when the cork is of esteemed thickness and quality. The bark is removed by making longitudinal and transverse incisions so as to allow it to be taken off in flakes. When first removed from the tree the bark is curved; the pieces are flattened by placing them in water and laying heavy weights on them; they are afterwards held over a blazing fire till the surface becomes scorched or blackened, which has the effect of closing the pores and giving a closer texture to the cork.

The best cork is not less than one and a half inches in thickness; it is supple, elastic, neither woody nor porous, and of a reddish color. Yellow cork is considered of inferior quality, and white cork, which has not been charred on the surface, as the worst. Although the charred surface is considered evidence of good quality, yet it is said that the charring process has a detrimental effect, as it secretes an empyreumatic oil, which is given off, and is frequently taken up by the liquid which the cork confines when in use. The firing is sometimes partially superseded by the process of boiling the cork and afterwards scraping its surface, which is said to be more effectual in closing the pores.

THE CAMPHOR TREE (*Camphora officinalis*).

This tree is a native of China and Japan, where it is found in great abundance, especially in the island of Formosa. The camphor plant flourishes in perfection in some of the Southern States, especially along the Gulf coast, and as many inquiries have been made in regard to the culture of the tree, the mode of collecting the camphor, &c., the following remarks are offered on these subjects:

With regard to culture, the plant grows rapidly from seeds which can be procured from the southern localities, where it seeds freely. The department has frequently received seeds from this source, which, when sown in a garden border, as the common garden pea is sown, rapidly vegetate and form plants from 18 inches to 2 feet in height the first season. Camphor is obtained by chopping the wood and roots into small pieces and boiling them with water in an iron vessel till the camphor begins to adhere to the stirring utensil; the liquor is then strained, and the camphor concretes on standing. It is afterwards mixed with a finely-powdered earth, and sublimed from one metallic vessel into another. In Japan the chips are boiled in a vessel to which an earthen head containing straw has been fitted, and the camphor sublimes and condenses on the straw. Crude camphor very much resembles moist sugar before it is cleaned. It is refined by sublimation, an operation which requires care and experience.

Camphor is also yielded by *Dryobalanops aromatica*, a tree a native of the island of Sumatra. This tree furnishes an oil called camphor oil, which is obtained from incisions made in the tree. A solid camphor is found in cracks of the wood, which is usually obtained by cutting down the tree, cutting it into blocks, which are split and the camphor extracted. This camphor is rarely found in commerce. The tree is too tender for the climate of the United States.

THE CINNAMON TREE (*Cinnamomum zeylanicum*).

This tree is a native of Ceylon, where it reaches to the height of 30 feet. It is cultivated in Java, Cochin China, and many of the East India Islands; it is also grown in several of the West India Islands, in Brazil, and other South American countries.

The best cinnamon is produced on light, sandy soils; strong shoots from rich soils produce a coarse, inferior article, deficient in aroma. The plant requires a tropical climate, and flourishes best in low, sheltered localities, where the atmosphere is moist and rains frequent during the period of most active growth. When cultivated for the bark the plant is not allowed to grow up to a tree; young plantations, after making four or five years' growth, are cut down to the surface of the ground; several shoots then spring up which are in turn fit for peeling in four to six years; a cinnamon plantation thus closely resembles a field of willows when cultivated for twigs used in the manufacture of baskets.

In the East Indies cinnamon-culture is conducted in a very systematic manner. Nurseries are provided for the preparation of young plants, which are usually raised from seeds which are collected from trees allowed to grow up for the particular purpose of furnishing them. The inner bark of the tree constitutes the cinnamon of commerce, the best being procured from young branches. The quality of the article depends upon the age and thickness of the bark, and several grades can be selected from a shoot six feet in length. In Ceylon the bark is peeled during the month of May, at which time it separates readily from the wood. The branches or twigs are cut and their outer bark stripped off; a longitudinal incision is then made with the point of a knife, and the inner bark or liber is gradually loosened until it is entirely removed; this, as it dries, curls up and forms "quills." Before these become dry and brittle the smaller are inserted into the larger; space in packing is thus saved, and complete sticks or *pipes* are formed, which are afterwards tied in bundles, and dried on open platforms under cover.

The cassia bark, or "*cassia lignea*" of commerce, is mainly furnished by *Cinnamomum cassia;* it is supposed that other species of the genus afford aromatic barks equally valuable and not distinguishable in market. But all the trees yielding this bark are natives of the warmer parts of Asia from India eastward, where the temperature may be considered as being strictly tropical. Cassia "buds" are the dried flower buds of the cassia tree; they bear some resemblance to cloves, and are used to flavor confectionery and for culinary purposes.

THE NUTMEG TREE (*Myristica moschata*).

This a native of the East Indies, but has been introduced and cultivated in the West Indies and in other warm countries; it forms a medium-sized tree and is grown in orchards; a nutmeg plantation and a peach orchard closely resemble each other.

Nutmeg-culture was at one time confined to the Banda Islands, and strong efforts were made to monopolize the production, a scheme which failed, it is stated, on account of birds carrying the seeds and dropping them beyond the assigned limits, and thus spreading the trees over the whole of the islands of the Malayan Archipelago, from the Moluccas to New Guinea.

The tree is cultivated to a limited extent in Jamaica, where it succeeds best in a deep, rich, friable soil, which is drained. Undulating ground is preferred in order to assist the running off of all superfluous water, as there is no one thing more injurious to the plant than water lodging around its roots, although in order to thrive well it requires an atmosphere of the most humid kind. Young plants are readily raised from fresh seeds. The fruit requires nine months of tropical weather to mature.

ALLSPICE, OR PIMENTO.

The allspice tree, *Eugenia pimenta*, is a native of the West Indies, where it is cultivated for its fruits, which are known in commerce as allspice. It is a very beautiful tree, and avenues planted with it in Jamaica are said to be greatly admired. As a shade tree, or as an ornamental tree on lawns and pleasure grounds, it is well worthy the attention of planters in the warmer parts of Florida. The berries have a peculiarly grateful odor and flavor, resembling a combination of cloves, nutmeg, and cinnamon; hence the name allspice. The berries are gathered while green and are laid in the sun to dry; when perfectly dry they are ready for storing. The leaves when bruised emit a fine aromatic odor, as powerful as that of the fruit, and yield on distillation a delicate odoriferous oil, which is said to be used in medical dispensaries as oil of cloves. Pimento berries bruised and distilled with water yield the pimento oil of commerce.

THE BAYBERRY TREE.

Eugenia acris, the wild clove, or bayberry tree of the West Indies, is a tree closely resembling the pimento tree. In Jamaica it is also called the black cinnamon tree. The refreshing perfume known as bay-rum is prepared by distilling the leaves of this tree with rum. It is stated the leaves of the allspice tree are also used in this preparation. As this tree is of rapid growth, and has beautiful evergreen foliage, which can be thus utilized by distillation, its introduction as an ornamental and useful plant is worthy of attention in orange-growing climates.

ARROW-ROOT.

The arrow-root, *Maranta arundinacea*, is a native of tropical America; it is largely cultivated in the East and West Indies for the starch contained in its roots.

The island of Bermuda has the reputation of producing superior arrow-root. The mode of culture adopted is very similar to that practiced in the culture of the common potato. The ground is well manured and plowed deep. It is then harrowed and laid out in drills about 6 inches in depth and 3 feet apart. In these drills the roots are set about 8 inches apart, covered with the plow, and the surface smoothed by harrowing. The plants require a whole year to mature, and economical planters set the drills somewhat wider apart and introduce an intermediate row of the potato, the crop of which is ready for removal before it can injure the arrow-root crop. Sometimes Indian corn is planted in these alternate rows, which is cut for forage while green; if allowed to mature the main crop would be impaired by it.

The mode of preparing the fecula from the roots greatly influences its value, and the superiority of the Bermuda article is attributed to the extreme care and cleanliness exercised in the processes of manufacture.

The roots, after being collected, are washed and their outer skin completely removed. This process has to be performed with great nicety, for the cuticle contains a resinous matter which imparts color and a disagreeable flavor to the starch which no subsequent treatment can remove. After this process the roots are again carefully washed and then crushed between powerful rollers, which reduces the whole mass into a pulp; this is thrown into large perforated cylinders where it is agitated by revolving wooden paddles, while a stream of pure water carries off the fecula from the fibers and parenchyma of the pulp and discharges it, in the form of milk, through the perforated bottom of the cylinder, from whence it is conveyed in pipes and passed through fine muslin strainers into large reservoirs, where it is allowed to settle and the supernated water drawn off.

After being repeatedly washed it is allowed to settle for some time, when the surface is skimmed with palette knives of German silver, in order to remove any slightly discolored particles which may appear on the top, and retaining only the lower, purer, and denser portion for drying for market.

The rollers and cylinders are made of brass and copper, so as to preserve the purity of the material.

The drying is conducted with equal care and cleanliness. The substance is spread in flat copper pans and immediately covered with white gauze to exclude dust and insects. These pans are placed on rollers and run under glass-covered sheds when there is any danger from rains or dews. When thoroughly dry it is packed with German-silver shovels into new barrels; these are first lined with paper, which is gummed with arrow-root paste.

The barrels are exported on the decks of vessels under cover; if placed in the hold the arrow-root might be tainted by the effluvia of other freight. Such are the processes employed and the care bestowed in the preparation of arrow-root in Bermuda.

THE CASSAVA PLANT.

The bitter cassava (*Manihot utilissima*) is a crooked-growing, shrubby plant which attains to a height of 6 to 8 feet. It is a native of tropical America, but long introduced into various tropical regions, where it is more or less cultivated for the starch contained in its fleshy roots. The roots contain a bitter, poisonous principle, which is readily separated by rasping the roots to a pulp and expelling the poisonous juice by heavy pressure; the pulp, being placed in coarse bags for the purpose of pressing, is afterwards placed upon heated iron plates, which has the effect of dissipating any of the poison which may remain after pressure. So volatile is this poison that when the fresh root is cut into slices and exposed for several hours to the direct rays of the sun cattle then eat it with perfect safety. The Indians also partake of the root after roasting it in hot ashes, and without any previous preparation.

The process of drying on hot plates lessens the nutritive value of the product, as many of the starch cells are thus broken and dextrine is produced, but this process is essential in order to get rid of the poisonous acid.

The fecula, or starch, is prepared by torrefying and granulating on hot plates; the grains burst and agglomerate in irregular gum-like masses, and in this condition is known as tapioca.

Brazilian arrow-root is the fecula that deposits from the expressed juice when it is allowed to settle, and is also known as cassava flour or mandiocca meal. An intoxicating beverage called piwarrie is made by chewing Cassava cakes, or dried pulp, and placing the masticated material into a vessel to ferment, after which it is boiled for use.

The juice of the root, concentrated by boiling, which also expels all injurious properties, under the name of cassareep, forms the basis of the West India dish called pepper-pot. It is highly antiseptic, and meat which has been boiled in it will be preserved for a much longer period than can be done by any other culinary process. In South America a sauce called arube is prepared by boiling down the fresh juice before the starch is precipitated; this is concentrated to a yellowish paste and seasoned with pepper; it is kept in stone jars and is used as a relish to fish. Tucupi sauce is made from the juice after the starch has been separated, boiled, and seasoned with peppers and small spices. It is used in a liquid form and tastes like essence of anchovies.

The sweet cassava (*Manihot aipi*) is supposed by some to be merely a variety of the preceding. Its roots are sweet and wholesome, and are eaten when cooked as any other edible vegetable. With the exception of the poisonous quality, the products of the sweet and the bitter cassava are precisely alike. The bitter plant is most cultivated because it is most productive.

The plants are propagated from cuttings made of the stem, prepared and planted in a manner similar to that employed in the culture of the sugar-cane. A warm, dry soil is essential. In wet soils the roots decay or are worthless. The most careful cultivators repress the flowering buds, so as to increase the size and vigor of the leaves, upon which depends the greater increase in the size of the roots.

THE PISTACIO NUT.

The *Pistacia vera*, which yields the pistacio nuts of commerce, is a small tree, a native of Western Asia, but has long been cultivated in Southern Europe. Its climatic requirements being similar to those of the olive, it may be expected to flourish in many of the Southern States. The fruit is a thin-shelled, oval, acuminate nut, which is esteemed as being of a more agreeable flavor than the filbert or the almond, and is sometimes made into articles of confectionery. Peculiar horn-shaped galls are collected from the leaves, which are used for dyeing silk a green color.

CHIOS TURPENTINE.

This substance is much sought after for medicinal purposes. It is furnished by the terebinth tree, *Pistacia terebinthus*, a medium-sized tree of Southern Europe and Northern Africa. The turpentine, or resin, is procured by making incisions in the trunk of the tree, from whence it flows quite freely if the operation is performed in early summer. At first the exudation is clear, of a honey-like consistence, and very fragrant, but quickly becomes thick and tenacious, and ultimately becomes hard when it is scraped from the bark. Galls, caused by the punctures of insects, are formed on the leaves. These are gathered and employed for dyeing and tanning purposes. One of the kinds of Morocco leather is said to be tanned by them.

VANILLA.

The vanilla of commerce is furnished by two species, *Vanilla aromatica* and *Vanilla planifolia*. These are succulent, climbing plants, natives of tropical climates, where they are cultivated for the sake of their pods. The best vanilla is said to be that produced in Mexico from *Vanilla planifolia*. Both species are in cultivation in the East and West Indies, also in various parts of South America.

The stems of these plants climb to the height of 20 feet and upwards, twining round the trunks of trees and throwing out a profusion of aerial roots, some of which eventually reach the ground, while others continue to float in the air or attach themselves to the tree. The leaves are thick and fleshy, as also are the greenish-white flowers. The pods, which are the most important part of the plant, are narrow and flattened, from 5 to 10 inches long, and of a dark-brown color; they are pulpy within and contain a great number of very small, dark seeds.

The cultivation extended to the plants is very simple. A space is cleared around the foot of a tree, in which cuttings of the plant are set at the approach of the rainy season, and they soon begin to grow and spread themselves up the trunk. Weeds are carefully repressed on the cleared space in which the cuttings are set, and in about three years from the time of setting the cuttings the plants yield fruit. The fruits are gathered during December, at which time they become of a yellowish-green color. The details of preparation for market are varied. One mode is that of spreading the pods in the sun on woolen blankets, which are laid on straw mats. After about two months' daily exposure they are tied up in bundles of 50 and packed in tin boxes for sale.

Another method consists of stringing together a number of pods by the lower end, as near as possible to the foot-stalk; the whole are plunged for an instant in boiling water and then hung up in the open air, where they are exposed to the sun. After being thus exposed for a few hours they are lightly smeared with oil and laid in woolen cloths for a time, after which they are dried, and if not smooth they receive a second rubbing with oil to keep them soft and prevent them from becoming wrinkled. When vanilla pods are in good condition they become covered with an efflorescence of needle-like crystals of vanillic acid; the interior of the pod is then soft, unctuous, and balsamic.

ORRIS-ROOT.

The *Iris florentina* belongs to a genus of popular flowering plants, which have long been cultivated in gardens for their beautiful, many-colored, curiously-constructed flowers. The above-named species is a native of Italy, and is cultivated there and in Tuscany for its fleshy rhizomes, called orris-root.

In its fresh state the root is extremely acrid, and, when chewed, excites a pungent heat in the mouth which lasts for some time. It loses this when dry, and exhales a delightful violet fragrance, which makes it useful in scenting toilet and sachet powders.

When cultivated for commercial purposes, the roots are lifted in spring before the plants begin their annual growth; the top is cut off with a small portion of root, and then set out to form a new plantation.

The plants require a growth of three years before the roots attain sufficient size for harvesting, so that the farms on which the plants are grown contain plants in three stages of growth. When taken out of the ground the roots are spread out to dry; afterwards they are trimmed into shape for market. Dark-colored pieces are often bleached by the fumes of burning sulphur, which is very detrimental to them for perfumery purposes, although for bead manufacture they are improved by being whitened. The manufacture of orris-beads is quite an extensive industry; individual turners will sometimes work out two tons of the beads annually. For this purpose the root, having been slowly and perfectly dried, is cut with circular saws into cubes, which are then converted into beads. These have no beauty, but their fragrance is lasting and always fresh.

The chips and shavings from the turnery and pieces of broken root are used to produce the tincture or essence of orris. This is made by placing 8 pounds of the roots into one gallon of rectified alcohol, and the mixture allowed to stand for about a month; when drawn off the tincture is bright and ready for use. This extract enters largely into many of the celebrated perfumes and "bouquets," for although it possesses but little aroma itself it has the power of strengthening the odor of other fragrant bodies.

In the preparation of orris-powder the root is first perfectly dried, then crushed under millstones, and finally reduced to powder in a drug mill. The orris-powder thus produced is mixed with dry wheat starch in the proportion of 2 pounds of orris to 12 pounds of starch-powder; after being sifted and blended they are allowed to remain together for a time, when the starch becomes fragrant, and the product is the "violet powder" of commerce, which is largely used in the composition of tooth powders. Sachets of orris-flour give a delightful odor to clothes and linens in wardrobes or drawers.

PEPPER.

The black pepper of commerce is the seed of *Piper nigrum*, a half-scandent, or climbing plant, a native of India; it is cultivated in various warm countries. The plant is propagated from cuttings taken from its climbing, shrubby stem. Rich lowlands, but not wet, are selected for a plantation. Young plants are set about 10 feet apart, and their climbing habit rendering it necessary to provide them with some support, a prop is set along with each plant; these props are generally made of rough-barked or thorny plants, and on account of being set when green, just as they are taken from the tree, they sometimes grow, which has given rise to the statement "that the pepper is planted near to the root of a tree upon which it climbs."

The tops of the plants are usually turned down after reaching a height of 6 or 8 feet, or to the top of the prop, so that a well-managed pepper plantation greatly resembles a vineyard when the vines are trained to poles or stakes. Much attention is given to careful culture, and an acre will yield on an average 1,000 pounds of pepper-corns. The berries, or fruits, are borne upon a spadix, that is, they are arranged in dense clusters round a central stalk. They are of a red color when ripe, but are gathered before being fully matured, and just as they begin to change from the green to the red-colored state. When gathered they are spread in the sun to dry, and when they shrivel and turn black are ready to be packed for market.

White pepper is the same fruit allowed to ripen; it is then gathered and soaked in water until the outer skin is soft, which is then removed by rubbing. The seed itself is of a whitish-gray color, and when dried forms white pepper.

Respectfully submitted

WILLIAM SAUNDERS,
Horticulturist, Pomologist, Landscape-Gardener, and Superintendent of Grounds.

Hon. Geo. B. Loring,
Commissioner of Agriculture.

REPORT OF THE BOTANIST.

SIR: I beg herewith to submit the following report of the work of this division for the past year:

GRASSES FOR TEXAS.

As the result of our many inquiries with reference to the native grasses of Texas, much information has been elicited respecting several species which give promise of fully meeting all the wants of that section of country. The principal need is of a permanent pasture grass, one which will yield well, bear the tramping of stock, and endure the drought of summer. Such a pasture grass would supply good grazing for nine or ten months of the year. During the two or three driest months the supply will generally need to be supplemented by annual grasses provided for that purpose. In many parts of Texas farmers do not feel any need of a supply of hay, as the winters are so open as to allow stock to graze in the open fields, provided suitable pasturage is furnished. However, in parts of the country where there is any liability to severe or protracted winter storms, it will be prudent to provide a supply of hay.

The grasses that thus far seem to offer the most promising results for permanent pastures are: Johnson grass (*Sorghum halapense*), Rescue grass (*Bromus unioloides*), Texas blue grass (*Poa arachnifera*), and the *Paspalum ovatum* described and figured in last year's report.

The *Poa arachnifera*, locally called Texas blue grass, has been known for many years as one of the native grasses of Texas, and during the past six years has been made the subject of some extended experiments, chiefly by Mr. Geo. H. Hogan, of Ennis, Ellis County. The species was first described by Dr. John Torrey in the report of Captain Marcy's exploration of the Red River of Louisiana, as having been found on the headwaters of the Trinity, and named *Poa arachnifera* from the profuse webby hairs produced about the flowers, although it is found that this is a variable character, probably depending somewhat on the amount of shade or exposure to which the grass is subject.

Several years ago Mr. Hogan sent specimens of the grass to this department, which were examined and determined by the botanist, and as it was shown to be a relative of the Kentucky blue grass, Mr. Hogan adopted for his species the name of Texas blue grass. We give below some extracts from his letters relating to the subject:

I call it Texas blue grass, and if it were possible to patent it I would not give it for all the mineral wealth of Texas. I find it is spreading rapidly over the country, and I claim for it *all* and *more* in Texas than is awarded to the *Poa pratensis* in Kentucky. It seems to be indigenous to all the prairie country between the Trinity River and the Brazos in our State. It blooms here about the last of March, and ripens its seeds by the 15th of April. Stock of all kinds, and even poultry, seem to prefer it to wheat, rye, or anything else grown in the winter. It seems to have all the characteristics of the *Poa pratensis*, only it is much larger and therefore affords more grazing. I have known it to grow 10 inches in ten days during the winter. The coldest winters do not even nip it, and although it seems to die down during summer it springs up as soon as the first rains fall in September and grows all winter. I have known it in cultivation some five years and have never been able to find a fault in it. It will be ready for pasture in three or four weeks after the first rains in the latter part of August or first of September. I have never cut it for hay. Why should a man want hay when he can have green grass to feed on? With a pasture well set in this grass you cannot run after your cows fast enough to get them to eat hay in our coldest weather. Very few of our farmers are paying any attention to grass, but most of them are raising cotton to the exclusion of corn, wheat, oats, &c., and I am convinced it will take some very severe lessons in experience to teach them that grass is the main stake in agriculture, either as hay or pasture.

Mr. S. C. Tally, of Ellis County, Texas, has sent specimens of this grass for identification. He says it is abundant there, bears heavy pasturing, and makes a beautiful yard or lawn grass. He went to Ennis to see the grass grown by Mr. Hogan as Texas blue grass, and was satisfied that his grass was the same. He will be glad to aid in bringing this grass to notice. He writes further as follows:

I have shown it to several Kentuckians from the blue grass region of Kentucky and they have become deeply interested in it, and some are of the opinion that it is very nearly equal to the Kentucky blue grass, which also grows well here when once set; the difficulty is in getting a stand owing to the looseness of the surface soil, unless the season is favorable. The Texas blue grass, if we accept Mr. Hogan's name, comes spontaneously apparently where all other vegetation is killed by tramping. I find it by the roadside, by fences and hedges, and growing luxuriantly under Osage orange trees 15 feet high. Shade does not appear to hurt it any more than orchard grass.

Mr. C. B. Richardson, of Henderson, Texas, says of the same grass, the seed of which he obtained from Mr. Hogan:

I planted the seed in the spring in three short rows on quite a poor, sandy spot in my garden. They came up well and grew finely until the dry weather set in about the middle of June. It then appeared to dry up and I decided it to be a failure on high, sandy lands. But when the rains came on in September it started up afresh and is now (March 27) 6 inches high, after having been eaten to the ground in December and again in January. I planted the rows 2 feet apart, and while it was young kept down the crab grass. Now it has entirely sodded the space between the rows by means of its runners. It stood the very hot and dry summer when only four months from the seed. I am much pleased with it, and intend to save seed and plant a meadow in the fall.

Paspalum ovatum was described and figured in the report for 1880. Since then we have received specimens from a gentleman of Louisiana, without particular remarks as to its value, and more recently from our statistical correspondent at Guntersville, Marshall County, Alabama, Mr. A. J. Baker, who says it is one of their best perennial grasses, withstanding the severest drought, and is relished by all stock.

JOHNSON GRASS (*Sorghum halapense*) is growing in popularity as farmers become more familiar with its value as a hay grass. It yields a larger quantity of hay to the acre than Bermuda grass, but is coarser and inferior in quality. One correspondent says:

It produces enormously as a hay crop, but has the disadvantage of being eradicated with difficulty and is liable to spread to the cultivated grounds. It also requires a good soil. These objections tend very much to diminish its culture on a large scale, particularly on small and medium sized farms.

BERMUDA GRASS.

Mr. S. C. Tally, of Ellis County, Texas, says:

Bermuda is now the most popular grass here, and it is being planted by plowing up the Bermuda sod, cutting it up, and then scattering it on the land selected for pasture, and plowing it in shallow when the land is as wet as it will do to plow.

Of *Alfalfa*, or *Lucern*, he says:

Alfalfa also does well. The difficulty is in the first year. The weeds grow so rapidly in the spring that they smother the young plants unless sown very thick on clean land, or land nearly free from seeds of weeds. Our farmers are beginning to see the folly of their former neglect of the grasses and now would willingly pay more to have part of their land reset in grass than it cost them to have the sod broken and the grass destroyed, many of them having broken every acre to put in corn and cotton, and now cannot buy unbroken land near them, and have to feed their work stock as regularly in summer as in winter.

WILD OATS. *Avena fatua.*

In the description given of this grass in connection with the figure in another part of this report, it is stated that the common cultivated oat is believed sometimes to degenerate into the wild oat. The following case, described by Mr. J. G. Pickett, of Pickett's Station, Wisconsin, certainly seems to afford evidence to that effect. The circumstance can only be otherwise accounted for by supposing the accidental introduction of the wild oat through seed obtained from some foreign source. It shows also how easily this pest is spread after being once introduced into a field. Mr. Pickett writes as follows:

Inclosed I send you specimens of a plant known in this section as wild oats. The history of the plant is as follows: In the year 1856 Mr. Lucius Hawley, of this town, threshed with a machine about 15 acres of common white oats from the stack upon the ground on which the crop grew. The straw was indifferently piled up, and so remained through the winter. In the following spring the straw was set on fire, but being wet was but partially burned, and what remained was scattered over about an acre of ground, and with the balance of the field was plowed under and the field sown to spring wheat. At harvest time the threshing ground and the land upon which the partially burnt straw had been drawn was found to be completely occupied by a crop of oats, and so thick upon the ground as to have completely smothered the wheat. Mr. Hawley, supposing the oats were from those of the former crop, did not examine the grain closely, but cut the wheat and oats with a reaper, at the same time keeping the grains separate as much as possible, and he did not discover, until stacking the grain, that the oats were not the common oat, but something different from any he had seen before. The oats, ripening early, had shelled upon the reaper and were carried more or less over the entire field, and a crop of spring wheat again following, the new oats were found scattered over the whole field. This was the first known of this pest here, and up to this time (March, 1882,) it has continued to spread over the country by being mixed with seed wheat and oats, and transported from farm to farm by threshing machines until the damage done can hardly be estimated. It will effectually run out any crop and take entire possession of the soil. Seeding down the land for three or four years will eradicate the grain, and this is the only remedy yet found. This oat is a winter grain and will not germinate and grow until it has laid in or upon the ground over winter and been frozen. I have known a field of 40 acres sown in the spring with clean seed wheat and nothing else, from which was threshed 600 bushels of these oats and wheat, about equaling the amount of seed sown. The oat, while growing, looks precisely like the common oat, but ripens early and shells easily. The kernel, when ripe, is nearly black, and has attached to it a spiral barbed tail, by which it will attach itself to clothing, grain bags, and to every crevice about a threshing machine, fanning mill, or reaper, and will even penetrate the skins of animals. When cleaned the grain weighs from 12 to 18 pounds per bushel, and is only used by finely grinding the grain for stock, or by cutting, before ripening, for hay, of which it makes a good quality. My own theory of its origin is that by the action of fire and the winter exposure the common oat on the farm of Mr. Hawley changed its variety and nature into this wild winter oat, which is now the worst pest this part of Wisconsin has yet known.

CIRCULAR LETTER.

The following circular was sent to the correspondents of the department and to others interested in grass-culture in the South and West, to which a large number of replies were received, a digest of which follows:

DEPARTMENT OF AGRICULTURE, DIVISION OF BOTANY,
Washington, D. C., November 16, 1881.

SIR: I am well aware of the immense importance of the grass crop to the agricultural interests of the country, and that many districts are subject to heavy losses and disadvantages from the want of grasses suitable to their peculiarities of soil and climate.

With the purpose of doing all that is possible for the benefit of the country in this direction, it is desirable to obtain very full information from all observing and progressive farmers and stock-raisers concerning the different kinds of grasses which, in their respective districts, are found valuable, and the various conditions of soil, moisture, or elevation which affects their successful culture. The acquisition of such information will, we hope, enable us to arrive at some conclusions that will be of service to the country, and to this end we ask your attention to the subjoined questions, hoping that you will give as full replies as possible.

1. What are the natural pasture grasses of your district?
2. Are any natural pasture grasses cut for the hay crop; and, if so, what?
3. What cultivated grasses are used for making a hay crop?
4. Have any experiments been made, to your knowledge, in the introduction of new grasses; and, if any, what?
5. Please suggest any grasses that might be useful in your section.
6. What is the character of the soil upon which each kind of cultivated grass does the best?

An early reply is respectfully requested.

Truly, yours, &c.,

GEO. B. LORING,
Commissioner of Agriculture.

DIGEST OF INFORMATION RECEIVED.

Some 350 returns were received to the circulars sent out. In many instances the answers to the inquiries were not so full and complete as desired. Some, however, in addition to the formal report, wrote more fully upon the subject, giving the value of particular grasses for grazing and hay, and their comparative merits, together with some of the causes which have operated to produce failures.

As a general thing the correspondents were not acquainted with the botanic or technical names of the grasses, and gave the common or local name where there was one. It frequently happens that the same grass will have different local names even in places not far remote from each other, and also that the same name will be applied to grasses very unlike. Many have no common name, and are referred to as wild grass, woods grass, swamp grass, &c.

So, in examining the reports, a perplexing difficulty was often encountered in not being able to determine to what species a grass belonged from the name given. In some instances this difficulty was obviated by obtaining specimens of the plants referred to; in others they were not sent, or failed to reach here.

The reports were sent in with commendable promptness, and all evinced a great interest in the subject, and expressed a strong desire to aid the undertaking by all means in their power.

WASHINGTON TERRITORY AND OREGON.

From Washington Territory twelve reports were received, and from Oregon thirty-one. They are so much alike that we consider them together.

NATIVE PASTURE GRASSES.

Bunch grass is found in the drier places and on the hills. Wild pea-vine and a few wild grasses in the timber; clover upon bottom-lands; wild-rye grass, a species of *Elymus*, upon lowlands, and a variety of mixed grasses upon the prairies.

Several species of grass are called bunch grass, the principal of which are *Poa tenuifolia* Nutt., *Festuca scabrella*, *Eriocoma cuspidata*, and some of the species of *Stipa*.

Bunch grass, which formerly was the principal pasture grass upon the uplands, has become about extinct, partly from the land being taken for cultivation and partly from overfeeding. Its place has been taken by wild chess (*Bromus secalinus*) and other poor grasses.

But little native grass is cut for hay, some little wild red top, wild-rye grass, salt marsh grass upon tide-water, and east of the Cascades a little bunch grass is cut.

CULTIVATED GRASSES.

Timothy is found universally distributed throughout this section, and has become so well established that some consider it indigenous. It has so tenacious a hold upon the soil that it can scarcely be killed out. As a hay grass timothy has no superior; for a pasture grass it gives out too early in July.

Next in general diffusion come the clovers and orchard grass. Red top also is quite common. Kentucky blue grass, though not so extensively introduced, seems well adapted to some portions of this section.

The soil and climate of Oregon and Washington Territory are admirably adapted to the culture of grass, and any kind will do well if allowed a fair chance. There is a great diversity of soil; and often on the same farm all kinds may be found, from the black sandy loam to red clay.

From some come inquiries for a grass that will do well upon lands worn out by constant wheat-cropping. Others say that they are sowing clover on their exhausted lands to recuperate them, and no better advice can be given the former than to do likewise. By this means the tired lands can soon be restored to fertility.

A better way, and one which the intelligent farmers will soon learn to follow, is to avoid depleting the land at all, but by a suitable rotation of crops, among which the clovers and grasses should have a prominent place, the lands can be kept in a normal state of fertility, and being naturally rich will yield a generous reward to the husbandman's toil.

CALIFORNIA.

From California thirty-seven reports were received. They give the following as the principal grasses:

NATIVE PASTURE GRASSES.

Wild oats (*Alvena fatua*), alfilaria (*Erodium cicutarium*), bur-clover (*Medicarga denticulata*), wild clovers, of which there are several species, and bunch grass, in the order named. In the northern part of the State a little wild-rye grass (*Elymus*), wild red top, and wild pea vine are found.

Accounts from the central and southern counties state that the native bunch grass, which formerly furnished a nutritious feed for a large part of the Pacific slope, has of late years become about extinct, and in some sections the alfilaria, bur-clover, and other forage plants, which were found on the uncultivated lands during spring and early summer, are slowly but surely dying out, and their places are being taken by a worthless grass that nothing will eat, green or dry.

Mr. C. O. Tucker, of Ballena, attributes this gradual disappearance of the native grasses to the constant and too close pasturage at and prior to the time for maturing their seeds, and to a too persistent pasturage with sheep at other times, causing the ground to become thoroughly trodden and compacted. This has been followed, during the last few years, by unusually hot and dry summers. He knows of no section where the need of useful forage plants is more severely felt than here.

All the native grasses of California, except the bunch grass, are annuals; hence, between the vegetation of the seed and the time when the plants get large enough to furnish grazing is a period very trying to stock. A perennial that would afford feed during this time, they say, would be a very great acquisition.

Mr. Mart. Walker, of Saint Helena, says that there is an intense desire among farmers to obtain a grass capable of resisting the intense heat and drought of summer, and afford grazing for cattle during that period, and if possible one that will grow on poor soil. For the want of some such resource many districts are fast becoming worthless. He says that this results from the system of continuous cropping to which the land has been subjected for the last thirty years.

NATIVE GRASSES CUT FOR HAY.

Except wild oats and bur-clover but little native grass is cut for hay. In the northern part of the State a little wild-rye grass, wild red top, and in some localities rushes, are cut.

CULTIVATED GRASSES.

The various grains, as wheat, rye, and barley, cut when in the milk, are principally relied upon for hay in many parts of California. They come as volunteers, or very often after the grain is taken off a "half-cast" of seed is sown on the stubble at the first rain in the fall and harrowed in. Wild oats are cut extensively, and alfalfa (*Medicago sativa*), often called lucern, is cultivated largely for hay, especially in the southern part of the State, where by irrigation large crops are made.

In the northern and central counties timothy and clover are cut to some extent, and are commented on favorably. Thus far but very little attention has been given to this subject. The general system of farming in vogue here is so different from that of other parts of the country, and so few experiments have been made, that no particular grasses or forage plants can be recommended at this time.

Further experiments and developments will have to determine this important question.

IDAHO AND MONTANA.

Bunch grass is common throughout the hill country. In the lowlands the wild-rye grass and other coarse grasses are found. Timothy is found successfully cultivated everywhere. In Idaho clover is cultivated extensively, especially in the Boise Valley, where some very large crops are reported. Some farmers have put their whole places in it. The small red clover is preferred. Alfalfa succeeds well in Montana.

Timothy and clover are recommended for the bottoms, and alfalfa for the "bench lands." All the grasses would succeed well with attention. The soil and climate are well adapted to their growth, and all things seem favorable to their culture, both for pasture and hay. All the farmers have to do here is to avoid the mistake made in many new sections, that of overpasturing and continuous cropping, and for years to come they will have a never-ceasing source of wealth.

UTAH.

The principal native pasture grasses of Utah are the bunch grass, wire grass (*Juncus Balticus*), salt grass (*Vilfa depanperata*), and buffalo grass (*Buchloe dactyloides*).

The wire grass and salt grass are cut for hay. Lucern, or alfalfa (*Medicago sativa*), is cultivated for forage and hay to a greater extent than anything else, and succeeds well. In some counties scarcely any other forage plant is cultivated.

Clover is reported successful in some places and timothy in others, though neither has been cultivated largely.

NEW MEXICO.

The gramma grass (*Bouteloua*) is common on the high ground throughout New Mexico. On the river bottoms there is a little blue grass. Alfalfa has been cultivated more than any other forage plant, and on the bottoms it will thrive after the second year without irrigation. The millets have been raised some, and should receive more attention. No experiments worthy of note are reported.

The reports from Utah and New Mexico were so few in number and the area so great and so diversified that no suggestions can be made as to what grasses will be best adapted to this section. Many experiments will have to be made to determine this.

TEXAS.—NATIVE GRASSES.

From Texas there were sixty-nine reports. The natural pasture grasses consist of the mixed grasses usually found on the prairies which occupy so large a part of the State. The sage or sedge grass holds a prominent place among them, but when overpastured it is run out, and the mesquite, both hardier and better, takes its place. The mesquite is found in the northern, central, and southern parts of the State, but not much in the northeastern part.

The term mesquite is used somewhat indefinitely, being applied to a number of grasses, but here it is probable that the buffalo grass of the plains (*Buchloe dactyloides*) is meant. It is found chiefly on the black lands. The gramma grass (*Bouteloua*), of which there are some patches, is rapidly disappearing, and is being replaced by the mesquite. Prairie grass thus far has been the chief reliance for hay as well as pasture.

Texas has always been a great stock-raising State, and while the range was uninterrupted no attention was given to cultivating grass or to improving pastures. But of late years portions of the State have been rapidly filling up, and the range consequently diminishing, so now the farmers are giving considerable attention to improving their pastures and to the hay crop. This, intelligent farmers write, should receive all the encouragement and assistance possible.

Mr. Talley says that the greatest difficulty in making the culture of Kentucky blue grass a success is in getting it to live the first year. The same remark is applicable to most of the grasses. The main reason of failure he says is not so much on account of the drought as on account of the nature of the soil. It is loose and porous, and dries up very quickly on the surface; hence they often find it difficult to get a "stand" of turnips in the fall, or a "stand" of millet in the spring. The soil holds moisture well below the depth of 2 inches.

He further says:

> I have taken great interest in investigating the subject of grasses, and my labors were rewarded by finding a much greater variety on my place than I had ever suspected, and all I have to do is to cultivate and take care of what I already possess, and cut the weeds to prevent their shading and smothering out the grasses already in the ground.

Texas is naturally a grass State, and only needs fair attention to succeed. Johnson grass and Bermuda are receiving considerable attention, and for the most part are spoken of favorably.

Bur, or California clover, does well in this State, and is highly esteemed in California for the feed it affords, though the burs or seed-pods stick to the wool of sheep and impair its value. Alfalfa is cultivated largely here, and does very well. Timothy, orchard grass, and clover are not reported on so favorably as could be wished.

The millets are cultivated quite extensively and do well. Mr. Clarke, of Hempstead, Waller County, Texas, has recently sent to the department samples of several kinds, among which were specimens of the so-called double-headed German millet 4½ feet high, and estimated to yield 3 tons to the acre.

Mr. W. H. D. Carrington, of Austin, says that there is but one native grass cultivated for hay, and that is what is called Colorado bottom grass; sometimes called goose grass, and in some places Green River grass (*Panicum Texanum*). The method of culture most commonly adopted is the same as that for crab grass. It comes voluntarily after corn is "laid by." A few farmers have found it so profitable that they plow and harrow their land in winter and cut the grass as soon as it matures. In this way they secure two crops annually. It is preferred by all kinds of stock to Hungarian grass or to oats in the sheaf. It seeds itself freely. The hay sells now (February, 1882), at $25 per ton, while prairie hay sells at from $10 to $12 per ton. This might be introduced into the Southern States without requiring any change in the method of culture generally pursued. It is figured and described in the report for 1879.

THE SOUTHERN STATES.

The returns from Georgia, Florida, Alabama, Mississippi, and Louisiana are so similar in general character that they are considered together, differences being noted as they occur.

NATIVE PASTURE GRASSES.

By an examination of the returns from this section, crab grass (*Panicum sanguinale*) is found to be the most extensively diffused pasture grass for summer and fall grazing, while crow-foot (*Eleusine Indica*) is quite common in Georgia and Florida.

The sedge grass also holds a prominent place as a pasture grass in Georgia, Alabama, and Louisiana, being reported from nearly one-half the counties. Several grasses are called sedge and broom sedge. They are for the most part some species of *Andropogon* or *Stipa*.

Bermuda grass (*Cynodon dactylon*) is reported in over one-third of the counties, and is probably growing in many more, and though an introduced grass it has become so well established that it is generally referred to as a native. The wild-pea vine is also plentiful and in some places quite popular. In Florida it is said to do well on the poor sandy soil, and to endure the heat and drought of summer. Mexican clover (*Richardsonia scabra*) is spreading over the sandy uplands along the coast. Tick trifoil, or tickseed, two species of *Desmodium*, is frequent in rich woods, and is esteemed as a milk-producing plant. Nimblewill (*Muhlenbergia Mexicana* and *diffusa*) are found in open woods in the northern and central counties.

In Alabama and Mississippi Japan clover (*Lespedeza striata*) has spread extensively over the roadsides and uncultivated fields. It will grow upon all soils, even the poorest, and withstands the heat and drought of summer remarkably well. It spreads rapidly, and some say it will root out the broom sedge and even Bermuda. It is rather a coarse plant, and should be tried only in places unsuitable for the better grasses.

In Louisiana crab grass, though still common, is gradually giving place as a pasture grass to Bermuda and white clover. Several species of clover seem to be spreading over this section; some of them are said to afford considerable seed.

The bur, or California clover, (*Medicago denticulata*) is reported in two counties of Alabama, and has been successfully tried in Georgia. In California it is highly esteemed.

Paspalum ovatum is found in Texas and Louisiana. It is highly spoken of as a pasture grass by those who have examined it. (See report of the botanist for 1880.)

Numerous other grasses are found growing with the foregoing species, but generally are of no particular value, and, having for the most part no common names, they are spoken of as wild grasses, &c.

In regard to native pasture grasses, Mr. Hawkins, of Hawkinsville, Ala., says:

> There is but very little grass of any kind here, except the wild varieties which come spontaneously on all old fields with the broom sedge, and our very best pastures are on these old fields. Old fields, when turned out, usually grow weeds the first two years and require about four years for them to become sodded with broom sedge. Burn this off in early spring, and with sufficient cattle it need never be burned again, as the cattle will keep it down. I have an excellent pasture of 150 acres of this kind, which will keep in good condition 30 head of cattle, half as many mules when not at work, and some hogs.

NATIVE HAY GRASSES.

In this section crab grass is cut very extensively, being reported from nearly every county where any attention at all is given to hay. Crowfoot, as a crop grass, is chiefly confined to Georgia. Some of the coarse swamp grasses are cut to a considerable extent in certain localities.

CULTIVATED GRASSES.

Over one-half of the reports from this section state that no attempts have been made to cultivate grass for hay. They rely entirely upon the volunteer grasses, the principal one being crab, which some consider to to be superior to the so-called cultivated grasses.

The chief reasons given in favor of crab grass as a pasture grass and for hay are that it is indigenous, and therefore well adapted to withstand the effects of the climate; that the ground has only to be smoothed after the corn is "laid by," and it comes voluntarily; that it never fails, and does well on poor and sandy soil.

In the remaining counties more or less introduced grasses have been cut for hay, consisting principally of herds grass (red top), the clovers, timothy, and orchard grass in the order named. Bermuda grass is reported to be cut for hay to a greater extent than any other, except the crab grass. The millets are cultivated for hay, and are deserving of more attention, for, being annuals, they can be grown successfully in all parts of the South. In Louisiana the cow-pea is considered one of the best forage crops, and its cultivation is extending. In the Red River district sorghum of various kinds is largely raised for feed.

JOHNSON GRASS.

Johnson grass is steadily growing in favor and its cultivation extending. It is being introduced on the low, wet prairie lands of Texas, and the reports are quite favorable. It is essentially a hay grass, and may be cut three or four times a year. It should always be cut before the seed stalks run up, else it will be too coarse. It is even more difficult to exterminate when once well set than Bermuda, hence should not be allowed to seed. The best way to eradicate it is by frequent plowings in July and August, exposing the roots as much as possible to the sun. It will not bear tramping.

Both this grass and Bermuda are regarded as a great blessing, or as an unmitigated evil, according to the standpoint from which they are viewed. The exclusive cotton-planter is apt to look upon them with unabated hostility, while those who are beginning to diversify their crops look upon these and other grasses as a great boon.

In these States hay should be secured early enough in the season to allow the meadows to get a good start before the summer drought sets in, so that the roots may have a good protection during this trying period. Meadows should not be pastured until the fall rains set in, and then only lightly, and never when the ground is soft from much rain. Care should be taken not to pasture too late in the spring, thereby preventing the grass from growing tall enough to cut before the heat of summer. According to the reports, the farmers are accustomed very generally to pasture too closely, which causes great injury, if not destruction, to the grass.

PERMANENT PASTURE.

For a permanent pasture grass the Texas blue grass (*Poa arachnifera*) promises to be one of the very best grasses yet brought to the attention of the South. It is a strong, deep-rooted grass, with an abundance of foliage, and seems to possess all of the characteristics necessary for a grass to be successful in most parts of the South. It grows in woods or open prairie, and thrives upon a variety of soils, poor as well as rich, but has not so far as reported been tried upon a dry, sandy soil. This grass seems worthy of earnest consideration by all interested. As it is figured and so fully described in another part of the report, more need not be said here.

The Texas blue grass dies down during the heat of summer and springs up with the first fall rains and lasts till summer again. Bermuda comes in early spring and lasts till frost comes, thus being a *summer* pasture grass.

WINTER PASTURE.

From several places, especially in Georgia and Alabama, requests come for a grass that will make good winter pasture, and if possible one that will succeed upon weak, sandy soil. The cultivated grasses best adapted for winter pasture at the South are the tall meadow oat grass (*Arrhenatherum avenaceum*), which will thrive on more sandy soil than most of the cultivated grasses (though it prefers a rich upland), and will yield more green food in winter than any other grass.

Orchard grass (*Dactylis glomerata*) is next in value. It does well in orchards and thinned woods, and will do well on any rich, dry soil. After being cut or eaten down by stock it springs up again with great rapidity, thus rendering it of peculiar value as a pasture grass. Experiment demonstrates that these grasses will thrive and do well in the northern and central counties of the Gulf States, and ought to succeed in all sections, except, perhaps, on a very dry sandy soil. These two grasses are thought to endure the heat and drought better than other cultivated grasses. Italian rye grass (*Lolium Italicum*) is one of the very best grasses for this section—by being sown and harrowed in at the first fall rains it will be ready for pasture by midwinter, and will afford a rich pasturage during the latter part of winter and spring, and can then be plowed under for the following crop, thus enriching the land as well as furnishing abundant winter feed. By only pasturing very lightly a crop of hay can be cut and the stubble turned under for a following wheat or other grain crop. The attention of farmers cannot be too strongly called to this useful grass. Wild-rye grass (*Elymus*) and wild meadow barley (*Hordeum pratense*), also the common cultivated rye and barley, make excellent pasture.

BERMUDA GRASS.

Bermuda has of late attracted more than usual attention. It has been referred to and discussed by so many of the correspondents that an idea of the estimation in which it is held cannot better be given than by making a few extracts from their letters.

Mr. Hawkins, of Barbour County, Alabama, says that he is very certain now, and has been for years, that the great want of the South is a grass with which the tired lands may be seeded, and some return had while the land is being recuperated. Bermuda, he says, is the grass to do this if it seeded, and could be easily destroyed when the land is wanted for cultivation. These difficulties, he says, operate sufficiently to almost exclude it from the tillable land. A correspondent from Mississippi says:

> Bermuda is the grass for this country, resisting both the drought of summer and the frost of winter, and affording a richer pasturage than any other grass. With this for pasture, and the Johnson grass (*Sorghum halapense*) for hay, stock-raising will be more profitable than cotton.

Georgia has taken the lead in introducing Bermuda grass. In the central part of the State it is found in every county, and is steadily growing in favor. The report of the State board of agriculture for 1881 says:

> The hay crop of Georgia has been unusually fine in 1881. The clovers and cultivated grasses made heavy crops before the summer's drought commenced. Large harvests of Bermuda hay were realized in some of the counties of Middle Georgia, where this valuable grass is being more highly appreciated every year. It makes a hay inferior to none, with the advantage of being permanent when once well set. Quite a number of farmers now realize a better income from lands set in Bermuda than they did from the same when in cotton.

Another correspondent says:

> Bermuda, beyond all doubt, is the best grass for pasture, but for hay we need other grasses, and I am satisfied that Johnson grass is the one for that purpose. These two grasses have the power to make this section a great stock country.

Such expressions as this frequently occur in the reports: "Bermuda is the best, but the farmers are afraid of it."

Mr. F. Seip, of Rapides Parish, Louisiana, says:

> Of all the usual cultivated grasses none can compare in general usefulness to the Bermuda. It is invaluable as a pasture grass for all kinds of stock, furnishing, through nearly the entire year, and even in winter, under some circumstances, an extraordinary amount of food. For hay purposes it cannot be surpassed. Under favorable circumstances it will yield more to the acre than any other known grass with the exception, possibly, of lucern (*Medicago sativa*) and Johnson grass, the latter being too coarse to make superior hay.

Again Mr. Seip says of Bermuda:

> It can only be recommended for permanent pastures or meadows, as it is very difficult to eradicate, but still it is practicable to remove it. The best method, I think, is

summer plowing repeated frequently, followed by oats in the fall and winter, and after the oat crop by a heavy crop of pease. If this is well done there will be no trouble in making a crop of corn or cotton the following year.

Colonel Lane, in "Forage plants at the South," says, in reference to destroying Bermuda:

Upon ordinary upland I have found no difficulty in destroying it by close cultivation in cotton for two years. It requires a few extra plowings to get the sod thoroughly broken to pieces. The breaking should be done with a small plow first, and a harrow run over it once or twice in winter or early spring. Take advantage of the dry, hot months of summer to have the grass that may be found alive plowed and hoed, and exposed as much as possible to the sun. In ordinary seasons so much of the grass will be killed the first year that but little interference with the next crop need be apprehended.

Bermuda is essentially a southern, summer-pasture grass, and as such possesses superior qualities. It will thrive upon poor soil and stand the heat and drought of summer. It is nutritious and is eaten by all kinds of stock. It is permanent when once well set, provided it is pastured; otherwise, the broom sedge and other grasses will run it out. It requires tramping to flourish. The objections it encountered during the first years of its introduction have gradually given way, as the farmers have seen more of it, and have become better acquainted with its nature and habits. To make hay it requires a rich soil—a soil rich enough to produce good crops of timothy and the more valuable grasses. It is an ameliorating crop. A field kept in Bermuda a few years will become so much enriched that should it be wanted for cultivation the increased crops will more than pay for the extra labor and expense required the first year on account of the sod.

Often in the reports a request is made for a grass that will do well on their exhausted lands and yield some return while they are being recuperated. Lands naturally fertile, but depleted by cropping, if not "turned out in commons," can be recuperated by proper management through the agency of ameliorating crops, the particular ones to be used varying with the different conditions of location, nature of soil, &c., and cannot be entered into minutely here, but which the intelligent cultivator will soon learn to determine.

Immediate and constant returns, as some ask for, should not be expected from a soil already exhausted. But in a short time, by generous treatment, they can be brought to a condition to once more reward the toiler for his labor, and will prove in the end to be much more economical than to "turn the fields out" and wait thirty or forty years for the slow process of natural recuperation, expending, meantime, one's energies in clearing and bringing into cultivation new tracts, to be in turn abandoned and "turned out."

Some ask for a grass that will do well upon a soil naturally poor or barren. Such a soil will not yield anything without fertilizing, except a few worthless weeds or some of the coarser plants. Good grasses will not grow on land that will not produce medium crops of grain. By using fertilizers and turning under green crops the productiveness can be increased so as to give fair returns, and then by suitable rotation the land can be continuously improved.

EXPERIMENTS.

In nearly one-half of the counties, according to the reports, no experiments introducing new grasess have been made, while in many of the other counties they have been made only on a small scale, and were too often abandoned as failures before they had been fairly tested. Failures frequently result from not fully understanding the nature and requirements of the grasses, especially during the early stages of their growth. At first they are weak and of slow growth, and require special care until well established. They need to be protected from the vigorous and already well-rooted native species, and especially from being smothered and killed out by the dense growth of weeds. Neither should stock be permitted to commit depredations and tramp them out. Often from neglecting to take these precautions the grass dies out and the experiment is abandoned.

Some, however, by proper care, secure a good stand and have a promising prospect of success, but by overpasturing or pasturing at unsuitable times they are apt to exterminate the grass and attribute the failure to a want of adaptability of the grass to the conditions of soil and climate, or to the heat and drought of summer. Hence there is a wide-spread and often-expressed sentiment that introduced grasses will not succeed in the South.

It may be true that in the extreme South, in the Gulf belt, the intense heat and long drought of summer, combined with a weak, sandy soil, presents difficulties to the culture of grass, and the same things affect more or less all crops. But we have abundant testimony from those who have given careful attention to the subject that in a majority of cases the causes of failure are such as can be successfully overcome by proper management.

Mr. J. J. Barclay, of Wheeler, Ala., says:

> I have experimented on my place with most of the cultivated grasses, and find they do well if protected from the tramping and depredations of stock for one season. * * * I am confident of their success and feel that their introduction into this portion of the South will be of incalculable benefit to the country and people, and especially attractive to the immigrant, whose first question is, "Do grasses grow in your State?"

Another says that orchard grass, tall meadow oat grass, and Johnson grass will do well if properly attended to and the ground suitably prepared. Mr. Hawkins says that his experiments show that any of the grasses will do well upon rich loam, or on moist, stiff land, or on moist, sandy land. Mr. D. P. Hurley, of Pike County, says:

> I would add, on the important subject of grasses, that their cultivation is sadly neglected, not because the climate is hostile or the soil unadapted, nor because they cannot be successfully cultivated, but for the reason that diversified agriculture is practically disfavored.

Mr. P. M. Morehouse sent from Texas a sample of Kentucky blue grass, grown on the open prairie, without shade or extra care after well set. It has withstood the heat and drought of summer for three years extremely well.

Other extracts might be given, all tending to show that the grasses can be successfully cultivated in a large portion of the South. All through the northern and central counties no difficulties will usually be encountered in cultivating all the more valuable grasses that cannot be overcome by using good judgment in selecting the soil best adapted to each kind, giving suitable attention to the preparation of the ground, and giving the grass due protection during the first stages of growth. The experiments made in these counties and the success attending them fully demonstrate the truth of the above statements.

Yet there are large tracts of country, often embracing counties, where a meadow of grass is not to be found. Mr. Hawkins says that he does not know of a meadow of cultivated grass in Southeastern Alabama. Similar statements come from Louisiana. This unfavorable condition has arisen from several influences, which can only be referred to here. Among them may be mentioned the custom of exclusive cotton-planting, which has been so sedulously followed for so many years, leaving but little time for anything else; also the habit of "turning out" fields when depleted instead of recuperating them by ameliorating crops.

Another is the reluctance and hesitation which persons naturally feel about changing old-established ways for untried methods, without the encouragement and aid of example to guide them in their new enterprise. The want of seed has been quite an impediment to increased attention being given to the grass crops. The correspondents say that a liberal distribution of grass seed would relieve a deeply-felt need and do much toward determining the important question of extending grass-culture.

Portions of Florida and the district along the Gulf presents some difficulties to the culture of grasses as well as of other crops. This is due to several causes, and experiments will have to determine what forage crops are best adapted to this section, and what modes of culture are best suited to them. An experimental station established here would do much toward solving this important problem, and would also furnish useful and much needed information in regard to the best method of treating all crops.

Fifth inquiry: "Please suggest any grasses that might be useful in your section."

The replies to this request were somewhat limited, and often rather suggestive than definite. There are but few to be added to those already mentioned. But for convenience, all of the grasses recommended for trial by the correspondents will be given here, together with such suggestions as the general tenor of the reports and correspondence, and information obtained elsewhere, would seem to warrant. They recommend as follows:

For Washington Territory and Oregon.—Italian rye grass, orchard grass, the clovers, tall meadow oat grass, Kentucky blue grass, Texas mesquite, and Bermuda.

For California.—Timothy, large red clover, the millets, orchard grass, Italian rye grass, white clover, Guinea grass (*Panicum jumentorum*), Bermuda, and alfalfa.

For Idaho and Montana.—All the grasses for bottom lands, and alfalfa for "bench lands."

For Texas.—Alfalfa, Bermuda, timothy, the clovers, orchard grass, Johnson grass, and the millets, in the order named.

For Georgia.—Kentucky blue grass, orchard grass, herds grass (called red top in New England), timothy, the clovers, and alfalfa, in the order named.

For Florida.—Bermuda, alfalfa, Guinea grass (*Panicum jumentorum*), orchard grass, Johnson grass, and clover.

For Alabama.—Orchard grass, Kentucky blue grass, timothy, herds grass (red top), Johnson grass, alfalfa, and California clover.

For Mississippi.—Orchard grass, herds grass (red top), the clovers, Kentucky blue grass, and the millets.

For Louisiana.—Kentucky blue grass, orchard grass, Bermuda, timothy, herds grass (red top), the clovers, and alfalfa.

The above are the principal forage plants enumerated for trial. It will be observed that in some instances, instead of suggesting new grasses for trial, those are named which have already been so fully tried that there is no question about their success.

It appears from the reports and correspondence that the principal need of Washington Territory and Oregon is a pasture grass for the dry hills in place of the nearly extinct bunch grass; some are desirous that Bermuda and Texas mesquite be tried. The latter has already been reported as successful in several counties. There is some uncertainty concerning what grass is referred to, as several go under the name of mesquite. It is probable that some mean the *Buchloe dactyloides*, the buffalo grass of the plains, a valuable pasture grass and similar in habit to Bermuda. In Texas it is called mesquite. The suggestions of these correspondents appear worthy of attention.

In Southern California some wish Bermuda to be tried for their pasture land which cannot be plowed, and where the bur-clover, &c., is being tramped out. They also think that the Guinea grass (*Panicum jumentorum*) might possibly succeed.

The suggestions from Florida were from only a few counties; the general impression seems to be that crab grass and other native grasses are superior to the so-called cultivated ones. Some think that a grass will have to be obtained from Cuba or the tropics to be suited to the climatic conditions existing there.

Bur, or California clover (*Medicago denticulata*) and alfilaria (*Erodium cicutarium*), both valued in California, are deserving of consideration for the Southern States. Experiments will have to determine whether or not the climatic conditions here will be favorable to their success.

The culture of grass crops in the section of country under consideration is comparatively new and undeveloped, and the inquiries made through the circulars elicited in part its present condition and some of the more pressing wants, but the information afforded, though valuable, was not so full and complete as to enable the department in numerous cases to determine with sufficient exactness the kinds of forage plants best suited to their several wants.

To accomplish this will require further investigation, and must rest largely upon the result of experiments. These, to be of such practical value as the importance of the subject seems to demand, will need to be *systematically* and thoroughly carried on, either at experimental stations established by the department, or through the agency of intelligent cultivators in numerous locations, all working methodically and making frequent detailed reports through properly prepared blank forms.

A personal inspection of the prevalent modes of culture practiced in different places, and of the experimental crops in several stages of growth, would be a very desirable aid for determining the causes that operate to produce failure, and the best methods to pursue to afford a reasonable assurance of success in the cultivation of the different species of grasses which are subject to many varying conditions.

The subject is of such vital importance to all that no efforts should be spared for accomplishing the desired end. Those already made by the department have met with the most gratifying approval and commendations from every place to which the circulars were sent. A general desire is expressed for their continuance and much anxiety manifested for their success. The farmers all gladly proffer their services to aid in the work, and are anxiously waiting to see what will be done. The general tenor of the reports goes to show that seldom has a subject been presented which has awakened a more universal and deeper interest throughout the South and the Pacific slope than this.

DESCRIPTION OF GRASSES FIGURED.

POLYPOGON MONSPELIENSIS—Beard grass.

An annual grass frequent in California, Oregon, Arizona, and Utah, and sometimes found on the Atlantic coast. It is a native of Europe. The culms are from 6 inches to 2 feet high, rather stout, apt to be procumbent at the base, and often branching below. There are usually three or four leaves on the culm, which are broad, flat, 3 to 6 inches long, and somewhat rough. The sheaths are rather loose and striate, and the ligule long and obtuse. The panicle varies from 1 to 4 inches in length, contracted into a dense, cylindrical spike, of a yellowish-shining, green color, the long awns or beards of the flowers being very conspicuous. The spikelets are 1-flowered, very small, about one line long. The outer glumes are nearly equal, 1-nerved, notched at the apex, and extended into a slender awn or beard from two to four times as long as the glume. The flower inclosed by these two glumes is very small, the flowering glume usually having a fine, short awn; the palet is minute, very thin, delicate, and awnless. It is quite an ornamental grass, but of little agricultural value. (Plate I: *a*, spikelet; *b*, flower; *c*, flowering glume more enlarged.)

AGROSTIS MICROPHYLLA.

Apparently an annual or biennial, frequently with several culms springing from one root. Radical leaves few. Culms erect, rigid, 1½ to 3 feet high, with four or five rough and rather rigid leaves; the sheaths long and roughish, the leaves 3 to 6 inches long, two or three lines wide, gradually pointed. Upper part of culm naked. The panicle is 3 to 5 inches long, erect, rigid, spike-like, narrow, and densely flowered; sometimes interrupted below. The spikelets are densely crowded on the short, almost sessile branches, and single flowered. The outer glumes are slightly unequal, rather more than a line in length, awn pointed, narrowly lanceolate, scabrous or hispid on the keel, 1-nerved. The flower is very minute, consisting of a thin, flowering glume about half as long as the outer glumes, 2-toothed at the summit, and on the back furnished with a slender awn three times its own length, readily seen projecting beyond the outer glumes. There is no proper palet, or only a microscopic one. This grass gives some promise of utility. (Plate II: *a*, outer glumes; *b*, flowering glume with its awn.)

AGROSTIS EXARATA—False Red top.

This is one of the most variable of grasses. In the report for 1878 we gave a figure of the form common in the mountains of Colorado and eastward. We now present a figure of one of the western forms occurring in Alaska and southward to Oregon and California. It grows from 2 to 3 feet high, with a stout, firm culm, clothed with three or four broadish leaves 4 to 6 inches long. The culms and leaves are either scabrous or smoothish. The panicle is 4 to 6 inches long, pale green, rather loose, but with erect branches. There are five or more at each joint, and of unequal length (from half an inch to 2 inches), and flower-bearing nearly to the base. The spikelets, as always in this genus, are single-flowered. The outer glumes are acuminate, of about equal length, rough on the keel. The flowering glume is about one-third shorter than the outer glumes, rather acute, 4-nerved, and sometimes with a very short awn on the back. The palet, if present, is very minute, scarcely as long as the ovary. There is reason to believe that this will be a valuable grass in many localities, but as yet too little is known respecting it. (Plate III: *a*, outer glumes; *b*, flower.)

CALAMAGROSTIS SYLVATICA.

A coarse, perennial grass, growing in large tufts, usually in sandy ground, in the Rocky Mountains at various altitudes, also on hill-sides in California and Oregon. It furnishes a coarse forage in uncultivated land, but cannot be recommended for cultivation. The culms are from 1 to 2 feet high, erect, rigid, and leafy; the radical leaves are frequently as long as the culm and two or three lines wide, sometimes flat, sometimes involute and rigid. The culm leaves are from 3 to 6 or 8 inches long, and, like the radical ones, rigid and scabrous. The panicle is narrow and spike-like, 3 to 5 inches long, rather dense, sometimes interrupted below, and varying from pale green to purple. The rays are mostly in fives, very short and rough. The spikelets are single-flowered, about a quarter of an inch long, on short, roughened pedicels; the outer glumes are nearly equal, ovate-lanceolate, acute, the upper 3-nerved, the lower 1-nerved. The flowering glume is rather shorter than the outer ones, of similar texture, 3-nerved, 4-toothed at the apex, and bearing on the back a twisted and bent awn about one-half longer than itself; surrounding the base are a few short, silky hairs; there is also a hairy pedicel or rudiment of another flower. The palet is about as long as its glume, thin, 2-nerved and 2-toothed at the apex. (Plate IV: *aa*, outer glumes; *b*, flower.)

MUHLENBERGIA COMATA.

This has been heretofore known as *Vaseya comata*, but it differs too little from Muhlenbergia to be separated from it. It grows throughout the Rocky Mountain region in Colorado, Utah, Wyoming, Idaho, Nevada, and California, usually on the sandy or alluvial banks of streams. It grows in tufts from firm, creeping roots-stocks. There is reason to think it may be a valuable grass for arid regions. The culms are erect, simple, 2 to 3 feet long, leafy below, the leaves 3 to 6 inches long and roughish, the upper one at first inclosing the base of the panicle, the joints slightly pubescent. The panicle is 2 to 4 inches long, narrow, and somewhat dense, sometimes interrupted below, generally of a purplish or lead color, and soft texture. The rays are mostly in twos or threes densely flowered. The spikelets are single-flowered, nearly sessile. The outer glumes are very narrow, acute, nearly equal, 1-nerved, 1½ to 2 lines long. The flower is rather shorter, and is surrounded by a copious tuft of long, silky hairs arising from its base. The flowering glume is very narrow, acute, and terminated by a slender awn three or four times the length of the flower. The palet is slightly shorter than its glume, and acute. (Plate V: *a*, magnified spikelet.)

ERIOCOMA CUSPIDATA—Bunch grass.

This grass has a wide distribution, not only on the Sierras of California, but northward to British America, and eastward through all the interior region of Utah, Nevada, New Mexico, Texas, Colorado, and Nebraska to the Missouri River. It is a perennial, growing in dense tufts, whence its common name of bunch grass. The culms are 1 to 2 feet high, with about three narrow, convolute leaves, the upper one having a long, inflated sheath which incloses the base of the panicle, or apparently of a terminal and one or two lateral panicles. The radical leaves are narrow, rigid, and as long or longer than the culm. The panicle is about 6 inches long, very loose, and flexuous. The rays are in pairs, slender, at considerable distances, and are branched in pairs. The spikelets are single at the ends of the capillary branches, and are each 1-flowered. The outer glumes are about 3 or 4 lines long, inflated and widened below, gradually drawn to a sharp-pointed apex, thin and colorless, except the three or five green nerves, and slightly hairy. The glumes inclose, apparently, an ovate flower, which is covered externally with a profusion of white, silky hairs, and tipped with a short awn, which falls away at maturity. This apparent flower is the flowering glume of a hard, coriaceous texture, and incloses a similarly hard, but not hairy, and smaller palet. (Plate VI: *a*, spikelet; *b*, flower.)

STIPA SETIGERA—Beard grass, Bunch grass.

A perennial grass, growing in bunches on dry hills and plains from Oregon to Southern California, and eastward in Arizona and to Texas. The culms are 2 to 3 feet high, erect, somewhat pubescent at the joints, with about three leaves. The sheaths are long and somewhat seabrous, the upper one loose and inclosing the base of the panicle; the blade flat, 2 or 3 lines wide, 4 to 6 inches long, roughish, long-pointed; the upper one nearly as long as the panicle, which is about 6 inches long, loose, the rays slender and in pairs, rather distant, near the extremity bearing the few spikelets on short pedicels. Spikelets 1-flowered; the outer glumes ½ to ⅔ of an inch long; the upper one rather shorter, narrow, acute, purplish, and 3-nerved. The glumes inclose the flower, which, as in other species of this genus, consists of a flowering glume rolled together in cylindrical form, inclosing a short palet, stamens, and pistil. This flowering glume at the base has a short, hairy point called a callus; it is also sparingly hairy above, with a hardened ring at the top, to which is attached a slender, twisted awn 2 to 3 inches long, the lower part of which is softly pubescent. Professor Brewer says: this is the most common and most valuable "bunch grass" of the hills in California. (Plate VII: *a*, outer glumes; *b*, flower, with its awn.)

STIPA EMINENS—Feather grass.

This species is very common in California on dry hills, growing in rather small tufts, with numerous short and narrow root-leaves. It is a perennial, growing usually 2 to 3 feet high, with rather slender culms and slightly hairy joints. The leaves are very narrow and convolute, rather rough and rigid, the lower ones about half the length of the culm. The panicle is rather narrow, but open and loose, usually about 6 inches long, at first sheathed by the upper leaf, but becoming exserted; the rays are slender, in pairs, and flower-bearing above the middle. The spikelets are single-flowered, the outer glumes about half an inch long, very narrow, 3-nerved, and long, sharp pointed. Inclosed between the glumes is the flower, which at first view may be taken for the grain or seed. It consists of a flowering glume, closely rolled together in a cylindrical form, inclosing the short palet and the flowering parts, and terminated by a twisted and bent awn about an inch long, which readily separates from the proper glume. This is nearly half shorter than the outer glume, hairy and pointed at the base, with scattered hairs on its external surface, and at the apex crowned with a ring of very short hairs. The species closely resembles the *Stipa avenacea*, or oat grass of the Eastern States. (Plate VIII: *a*, outer glumes; *b*, flower with its awn.)

AIRA DANTHONIOIDES.

A slender, annual grass, common in Oregon and California, growing in moist meadows, where, according to Mr. Bolander, it often forms a large portion of the herbage. From its slender culms and small leaves it cannot furnish a large bulk of hay. The culms vary from 3 inches to a foot or two in height, sometimes bent and branching at the base. The leaves are 1 or 2 inches long and very narrow; the upper sheaths are very long. The panicle is loose, very slender, usually 2 to 5 inches long, the lower rays being in twos or threes, the upper ones in pairs or solitary. The rays are distant, appressed, branching from below the middle, and few-flowered. The spikelets are 2-flowered and on slender pedicels. The outer glumes are about three lines long, lanceolate, gradually acutely pointed, 3-nerved, and slightly rough on the keel. The two flowers are together shorter than the outer glumes, being each about one line long, each with a small tuft of white, silky hairs at the base, and a hairy pedicel continuing the rachis. The flowering glumes have a truncated apex, with four small teeth, and a fine awn on the back inserted about the middle, which is three or four times as long as the glume, and usually more or less twisted and bent. (Plate IX: *a*, spikelet; *b*, flower enlarged.)

TRISETUM CERNUUM.

This grass grows to the height of 2 or 3 feet, with flat, wide leaves, which are about 6 inches long, and fine, open, spreading panicle, 6 to 9 inches long. The rays are slender, solitary, or sometimes clustered below, and much branched from near the middle. The spikelets vary from one-quarter to nearly half an inch in length, and have two to three or, rarely, four flowers each. The outer glumes are very unequal, the lower one being very narrow and awl-shaped; the upper one broad, 3-nerved, obtuse, and tipped with a fine point, and longer, sometimes twice as long as the lower. The rachis of the spikelet is clothed with fine, rather long hairs. Each flower consists of a lanceolate flowering glume, ending in two slender, pointed teeth, and bearing on the back, near the point, a slender awn twice its own length; a narrow palet, rather shorter than its glume; and the inclosed stamens, and a somewhat hairy ovary. Of this grass Mr. Bolander remarks that it deserves further attention. It grows on dry hill-sides near the bay of San Francisco and Oakland hills, and also extends northward to Oregon. (Plate X: *a*, outer glumes; *b*, flowers.)

TRISETUM SUBSPICATUM.

A perennial grass of the mountaineous regions of Europe and North America. It is found sparingly in New England, near the great lakes, in the Rocky Mountains of Colorado, Utah, California, Oregon, and northward to the Arctic circle. It varies in height according to the altitude at which it grows, being sometimes reduced to 3 or 4 inches, at other times running up to 2 feet high. The culms are erect and firm, smooth or downy. The leaves are flat and from 1 to 4 inches long. The panicle is spike-like, dense, and cylindrical, or elongated, and more or less interrupted, generally of a purplish color. The spikelets are flat and 2 to 3 flowered. The outer glumes are unequal in size, the lower one being shorter and 1-nerved, the upper longer (about three lines long), broader, and 3-nerved, both scarious on the margin. The flowers are slightly longer than the outer glumes; the flowering glumes are lanceolate, acute, slightly scabrous, 5-nerved, 2-toothed or bifid at the apex, scarious and purplish on the margins above, and bearing on the back above the middle a stout awn slightly longer than its glume. The palet is thin, membranous, 2-nerved, and 2-toothed at the apex. (Plate XI: *a*, outer glumes; *b*, flowering glume and its awn.)

AVENA FATUA.

This is the so-called wild oat which occurs so commonly in California. It is generally thought to have been introduced from Europe where it is native, but it has become diffused over many other countries, including Australia and South America. It is held by some to be the original of the cultivated oat, *Avena sativa;* that the common oat has been known to degenerate into the wild oat, and also that by careful cultivation and selection the wild oat has been changed into the common cultivated form. But on this question there is conflict of opinion, and the alleged facts are not yet sufficiently established. The wild oat differs from the common one chiefly in having usually more flowers in the spikelets, in the long brown hairs which cover the flowering glume or chaff, in the constant presence of the long, twisted awn, and in the smaller size and lighter weight of the grain. It is a great injury to any grain-field in which it may be introduced, but for the purpose of fodder, of which it makes a good quality, it has been much employed in California. (Plate XII: *a*, outer glumes; *b*, flowers.)

DANTHONIA CALIFORNICA.

This is a perennial grass, not very common, variable in height, usually 1 to 2 feet, with narrow, convolute, and long-pointed root-leaves; those of the culm somewhat wider, 3 or 4 inches long, the lower sheaths hairy, especially at the throat. The panicle usually consists of from 3 to 5 spreading rays, each of which is terminated by a single spikelet. The spikelets are usually 5 to 7 flowered, widening upward. The outer glumes are about as long as the spikelets, three-quarters of an inch long, linear, lanceolate, acute, keeled, 5 to 7 nerved, and purplish. The flowers are somewhat crowded on the axis. The flowering glumes are broad, thickish in texture, obscurely 9-nerved, smooth on the back, but the margins below the middle fringed with long silky hairs; the apex terminates in two sharp-pointed teeth, between which is a flattened and spirally-twisted awn, which is about equal in length to the palet. The proper palet is about as long as its glume, obtuse and notched at the apex, and ciliate on the margins. This is a somewhat ornamental grass, but not, probably, of much agricultural value. (Plate XIII: *a*, outer glumes; *b*, lower flower; *c*, flowering glume more magnified.)

KŒLERIA CRISTATA.

This grass has a very wide diffusion, both in this country and in Europe and Asia. It favors dry hills or sandy prairies, and on the Great Plains is one of the commonest species. It occurs throughout California and into Oregon. It varies much in appearance according to the location in which it grows; these variations being so striking that they have been considered different species, and perhaps two species ought to be admitted. It is perennial, with erect culms usually from 1 to 2 feet high, and a spike-like panicle varying from 3 to 6 inches in length and more or less interrupted or lobed at the lower part. When grown in very arid places the culms may be only a foot high, the radical leaves short, and the panicle only 2 inches long. When grown in more favored situations the radical leaves are 18 inches long, the stem 3 feet, and the panicle 6 inches long. The branches of the panicle are, in short, nearly sessile clusters, crowded above, looser and interrupted below. The spikelets are from 2 to 4 flowered. The outer glumes are a little shorter than the spikelets, lanceolate, acute, compressed. The flowering glumes are similar, membranaceous, acute or mucronate. The palet is of nearly equal length, thinner and 2-toothed at the apex. The flowers, panicle, culm, and leaves are unusually more or less softly hairy. It is readily eaten by cattle. (Plate XIV: *a*, outer glumes; *b*, flowers.)

MELICA BULBOSA—Bulbous Melic grass.

This species is particularly distinguished by its large bulbous roots, or, more properly, by the bulb-like enlargement of the base of the culm. It grows to the height of 2 or 3 feet; the leaves narrow, scabrous, and mostly involute. The panicle is 4 to 8 inches long, narrow, with short and distinct branches, which are mostly in pairs, erect and densely flowered. The spikelets are about half an inch long, with usually 3 or 4 flowers, the upper one sterile. The outer glumes are thin, broad, and obtuse, the lower one 3 to 5 nerved, the upper 5 to 7 nerved. The flowering glume is about a quarter of an inch long, obtuse, roughish, and 7-nerved. The palet shorter than the flowering glume and ciliate on the keels. This species grows in the mountain region of California and Oregon, also in Nevada, Utah, Wyoming. (Plate XV: *a*, outer glumes; *b*, flowers.)

MELICA IMPERFECTA.

There are seven or eight species of Melica in California, some of them quite common, but they do not appear to have much agricultural value. The *Melica imperfecta* grows in tufts in shaded ground. There are several varieties which differ considerably in size and general appearance. They may be described in general terms as growing from 1 to 3 feet high, with slender, rather wiry culms; the lower leaves are narrow, with long, tapering points, and about half as long as the culm, generally smooth or slightly scabrous. The roots are perennial with strong fibers. The panicle varies in the different varieties from 6 to 12 inches in length, rather narrow, with distant rays, which are very unequal in length, and in clusters of 3 to 5. The longer rays are 1 or 2, or sometimes 3, inches long, flower-bearing for half or two-thirds their length, while the shorter ones ½ to 1 inch long, are flower-bearing to their base. The spikelets are one-quarter inch or less in length and usually with two flowers, one of which is imperfect, sometimes, however, with three flowers, one or two of which may be imperfect. The outer glumes are frequently purplish, with thin, whitish margins, slightly obtuse, and 3 to 5 nerved. The flowering glume is about 7-nerved, usually purplish, rather acute; the palet of about the same length and 2-toothed. The imperfect flower has a short pedicel and is about half as long as the perfect one. (Plate XVI: *a*, outer glumes; *b*, lower flower; *c*, upper flower; *d*, sterile flower.)

POA CALIFORNICA—Bunch grass.

Common in Oregon and California; one of the numerous "bunch grasses" referred to in accounts of the wild pasturage of the country. The foliage is too scanty to make it of much agricultural value, but that defect may be compensated for by the abundant nutritious seeds which are said to be gathered for food by the Indians. It is near the *Poa tenuifolia* of the Rocky Mountains. The culms are from 1½ to 3 feet high, erect, and scantily clothed with a few short, narrow leaves. The panicle is erect, 3 to 5 inches long, rather narrow and loose, the branches mostly in fives, unequal, from ½ to 1½ inches long, flowering above the middle. The spikelets are 3 to 5 flowered; the outer glumes are oblong-lanceolate, about 2 lines long, nearly as long as the flowers, 3-nerved, rough on the keel, somewhat scabrous, and acutish. The flowering glumes are lanceolate, convex or slightly compressed toward the apex, indistinctly 5-nerved, 2 to 3 lines long, acutish, minutely scabrous, the apex and margins scarious and of a bronze or purplish color, sometimes slightly pubescent near the base. The palet is almost as long as its glume, narrower and bidentate at the apex. (Plate XVII: *a*, outer glumes; *b*, first flower; *c*, second flower; *d*, third flower expanded.)

POA ARACHNIFERA—Texas Blue grass.

The history of this grass is given in another part of this report. It is likely to prove one of the most valuable grasses for the South and Southwest. By means of its stolons or offshoots it multiplies rapidly and makes a dense, permanent sod. It produces an abundance of radical leaves, and those of the culm are smooth, long, and of good width, about 4 to 8 inches long, and 2 lines wide. The culms are 2 to 3 feet high, each with about two leaves, with long sheaths and blade, the upper one sometimes reaching nearly to the top of the panicle. The ligule is short and rounded, or lacerated when old. The panicle is from 4 to 8 inches in length, rather narrow, and with short, erect branches of unequal length, in clusters of from three to five, the longest seldom 2 inches, most of them short, nearly sessile, and profusely flowering to the base. The spikelets usually contain about five flowers. The outer glumes are ovate-lanceolate, acute, with whitish, scarious margins, and scabrous on the keel. The flowering glumes are longer, gradually sharp pointed and smooth, except on the margins and midnerve, which are sometimes pubescent. In many cases there is a remarkable development of long, silky hairs at the base of each flower, but sometimes these are quite absent. (Plate XVIII: *a*, spikelet magnified.)

DISTICHLIS MARITIMA—Salt grass, Marsh grass.

This is described in most botanical works as *Brizopyrum spicatum*, but recently the name given by Rafinesque has been accepted and restored to it by Mr. Bentham. It is a perennial grass, growing in marshes near the sea-coast on both sides of the continent, and also abundantly in alkaline soil throughout the arid districts of the Rocky Mountains. It has strong, creeping root-stocks, covered with imbricated leaf-sheaths, sending up culms from 6 to 18 inches high, which are clothed nearly to the top with the numerous, sometimes crowded, two-ranked leaves. The leaves are generally rigid and involute, sharp-pointed, varying greatly in length on different specimens. The plants are diœcious, some being entirely male and some female. The panicle is generally short and spike-like, sometimes, especially in the males, rather loose, with longer, erect branches, and sometimes reduced to a few spikelets. The spikelets are from 4 to 6 lines long, and 5 to 10 flowered, the flowers being usually much compressed. The outer glumes are smooth, narrow, and keeled; the flowering glumes are broader, keeled, acute, rather rigid, and faintly many-nerved. The palets have an infolded margin, the keels prominent or narrowly winged. The pistillate spikelets are more condensed and more rigid than the staminate. Although this cannot be considered a first-rate grass for agricultural purposes, it is freely cut with other marsh grasses, and on the alkaline plains of the Rocky Mountains it affords an inferior pasturage. (Plate XIX: *a*, outer glumes; *b*, male flower; *c*, female flower.)

FESTUCA MICROSTACHYS—Small Fescue grass.

A slender annual grass, which is very common in California and Oregon, and considerably resembling the small fescue of the Eastern States (*Festuca tenella*). The culms are slender, from 6 to 18 inches high. The leaves are short and narrow. The panicle is from 2 to 5 inches long, with few rather distant, short rays, which are mostly single at the joints, and apt to be one-sided, sometimes with the lower ones spreading or reflexed. The spikelets are from 2 to 5 flowered, on short, thickened pedicels, varying from smooth to pubescent. The outer glumes are acute, the upper one 3-nerved, about one line long, and longer than the lower one, which is 1-nerved. The flowering glumes are 2 or 3 lines long, with an awn nearly twice as long; the palets have each two short, bristle-like teeth, which often project beyond the flowering glume. The grass is of little value, except as it helps to extend the pasturage of uncultivated grounds. (Plate XX: *a*, outer glumes; *b*, *b*, *b*, flowers.)

ELYMUS CONDENSATUS—Giant Rye grass.

This is a perennial grass, ranging from San Diego throughout the State, and into Oregon and Washington Territory, also in the Rocky Mountain region of the interior. It is very variable, but always a strong, heavy-rooted, coarse grass, from 3 to 6, or even to 12, feet high. Mr. Bolander states that it seems to do excellent service by fixing the soil on the banks of creeks and rivers. In the larger forms the culms are half an inch thick. The leaves are smooth, 2 feet long, and an inch wide, or more, and the panicle 8 to 14 inches long and an inch and a half thick. As it usually occurs in arid grounds, it is from 3 to 6 feet high, the leaves about a foot long and half an inch wide, and the spike-like panicle 4 to 8 inches. In the large form the branches of the panicle are subdivided and one or two inches long. More commonly there are two to five sessile spikelets at each joint of the rachis, the spikelets about 3-flowered. The outer glumes are subulate or short, bristle-like. The flowering glumes are mostly coriaceous, 5-nerved, rounded on the back, and acute or mucronate pointed.

There is a variety called *triticoides*, which has a more slender, less crowded spike, the spikelets more distant, not more than two at a joint, and frequently single, the culm more slender, and the leaves narrow or involute. This variety seems to unite the genus to Triticum. (Plate XXI: *a*, spikelet; *b*, outer glumes; *c*, flower.)

ERODIUM CICUTARIUM—Pin grass, Alfilaria.

This is a common forage plant in California, and although it occurs sparingly in different parts of the United States is not elsewhere economically employed. It is properly neither a grass nor a clover, but a plant belonging to the geranium family. It is a low, branched, spreading, annual plant, seldom more than 2 feet high, the stems juicy and hairy, the leaves pinnate, 3 to 6 inches long, consisting of about six pairs of leaflets, which are ½ to 1 inch long, gashed with teeth and divisions reaching half or more than half to the midrib. The flowers arise from an axil or joint of the stem on a peduncle longer than the leaves, which at the top forms an umbel of 4 to 8 flowers, each borne on a slender stalk or pedicel ½ to 1 inch long. The small flowers consist of 5-lance, oblong sepals, 2 or 3 lines long, 5 rose-colored petals a little longer than the sepals, 10 stamens, 5 of which are shorter and sterile, and an ovary composed of 5 carpels surrounding the central axis, each containing one seed. As the fruit matures the tops or styles of the carpels elongate to an inch or two in length, and when perfectly ripe they separate elastically from the axis; the long styles become much twisted and the seed is dispersed.

Professor Brewer, in the Botany of California, says of this plant: "It is a valuable and nutritious forage plant, reputed to impart an excellent flavor to milk and butter." (Plate XXII.)

TRIFOLIUM PROCUMBENS—Small Yellow clover.

This small clover is a native of Europe, which has become extensively naturalized in some parts of the country, particularly in the Middle and some of the Southern States. It has a perennial root from which spring several procumbent, slender, branching stems. Under favorable circumstances it rises to a foot or more in height. The leaves are numerous but small, having a very short petiole, and composed of three obovate or wedge-obovate leaflets, which are notched at the apex and finely toothed on the margin, except near the base. They are from one-quarter to half an inch long, and the terminal or upper leaflet is short-stalked. The stipules at the base of the petiole are short and ovate. The heads are one-quarter to half an inch in diameter, composed of from 15 to 20 small, bright-yellow flowers, and are borne at the extremity of slender stems or peduncles 1 to 2 inches long.

This clover is valuable as a volunteer in uncultivated fields, but furnishes too light a yield for profitable culture wherever the common red clover will thrive. (Plate XXIII.)

MEDICAGO LUPULINA—Hop medick, Black medick.

This plant has so much the appearance of small yellow clover (*Trifolium procumbens*) that a very careful examination is sometimes needed in order to distinguish between them. Their habit of growth is similar; the medick, however, is longer stemmed; the stems are more angular and hairy. Both have the flowers in small heads or clusters, and both belong to the clover family, but to two distinct genera. The main distinction is seen in the pods, which in *Trifolium* are small and generally included in the calyx, while in *Medicago* the pods are larger and bent or curved, in some species spirally twisted. In the black medick the pods are kidney-shaped, and when mature become of a blackish color. The leaves are very similar to those of the small yellow clover, but larger and broader. It is also a native of Europe, but has become extensively naturalized, and will often be found in the same field with the clover, generally spreading more extensively. In agricultural value it is probably about its equal. (Plate XXIV.)

MEDICAGO SATIVA—Lucern, Alfalfa.

This forage plant is extensively cultivated in California. Professor Brewer, in the Botany of California, says of it:

In cultivation it is probably the most valuable of forage plants for warm and dry regions. The root often reaches a depth of 8 or 10 feet and may endure for many years. The herbage is very nutritious, and on deep soils with proper moisture it yields several crops, in some parts of the State growing and blooming nearly through the year. There is no specific difference between the English and German lucern and the Spanish and Chilian alfalfa, but it is popularly believed that the Chilian variety is better adapted to this State than the European.

The plant reaches the greatest perfection as a fodder-plant under the system of irrigation. It belongs to the same family as the clover, growing from 2 to 4 feet high, with an upright, smooth stem, much branched above, and with an abundance of ternate leaves, ¾ to 1 inch long, oblanceolate, and toothed at the upper part. At the summit and ends of the branches the purple flowers are produced in small, oblong clusters, succeeded by numerous short, spiral-twisted, smooth pods. It is little known in cultivation in the Eastern and Southern States, and is deserving of more extended trial. (Plate XXV.)

Respectfully submitted.

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Hon. GEORGE B. LORING,
Commissioner af Agriculture.

POLYPOGON MONSPELIENSIS.

AGROSTIS MICROPHYLLA.

AGROSTIS EXARATA (var.).

CALAMAGROSTIS SYLVATICA.

MUHLENBERGIA COMATA.

ERICOMA CUSPIDATA.

STIPA SETIGERA.

STIPA EMINENS.

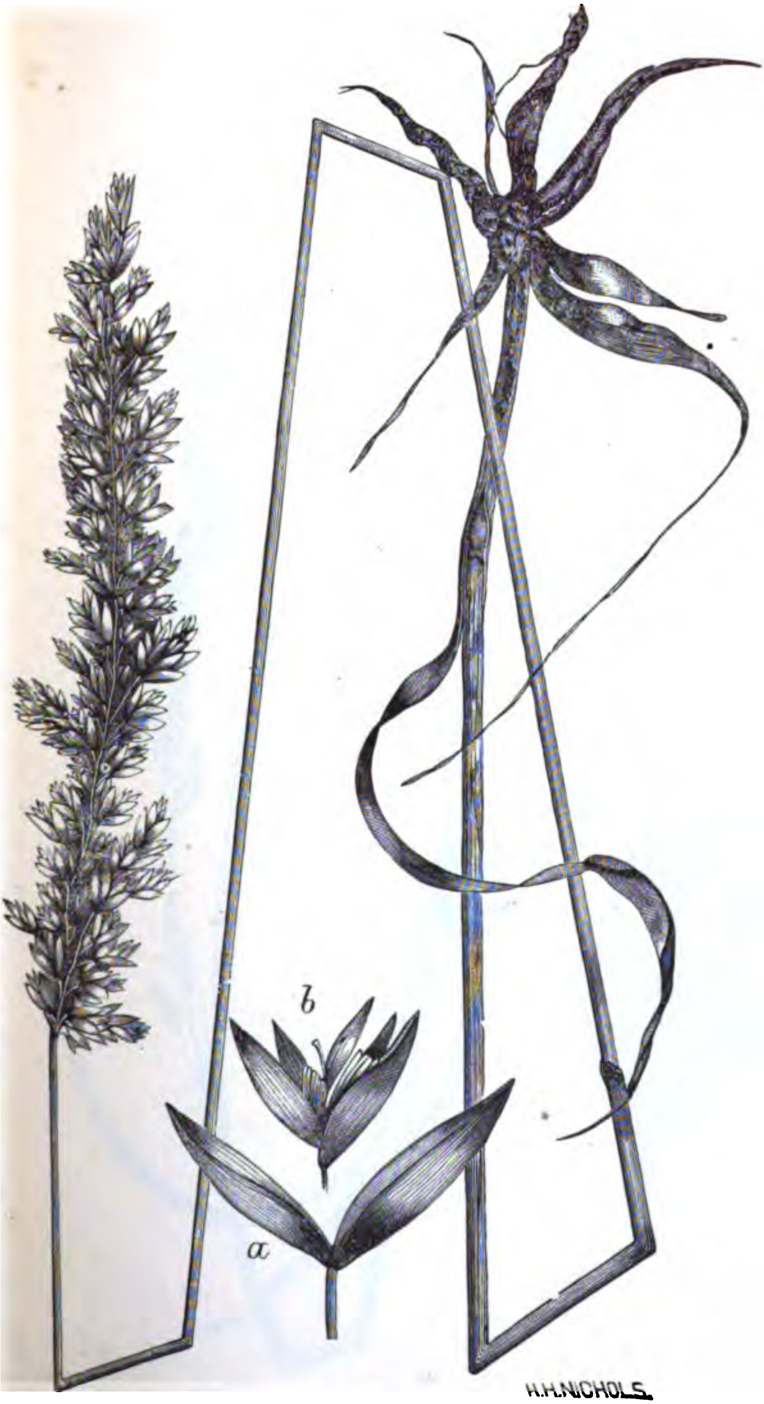
AIRA DANTHONIOIDES.

TRISETUM CERNUUM.

TRISETUM SUBSPICATUM.

AVENA FATUA.

DANTHONIA CALIFORNICA.



KOELERIA CRISTATA.

A.H.NICHOLS. T.TAYLOR.DEL.

MELICA BULBOSA.

Melica imperfecta (var.).

ATROPIS CALIFORNICA.

POA ARACHNIFERA.

DISTLICHLIS MARITIMA.

FESTUCA MICROSTACHYS.

ELYMUS CONDENSATUS.

ERODIUM CICUTARIUM.

TRIFOLIUM PROCUMBENS.

MEDICAGO LUPULINA.

MEDICAGO SATIVA.

VETERINARY REPORT.

The reports containing the results of the experiments conducted by Drs. Salmon and Detmers during the past year, together with much other information of a valuable character relative to the nature and cause of fatal and destructive diseases incident to domestic animals, will be found below. Dr. Salmon's report contains a detailed statement of his experiments with swine plague, fowl cholera, and Southern cattle fever. At the conclusion of his last year's work Dr. Salmon was convinced that an investigation of the contagious fevers of animals must be, to a large extent, an investigation of bacteria, and therefore it was necessary to devise an apparatus in which they might be grown without contamination from atmospheric germs. This apparatus would have to admit of the sterilization of the cultivation medium by heat, allow access for additions of virus and the removal of portions of the same for experimentation, without great danger of contamination from germs floating in the air. The rules to govern the sterilization were also to be developed; in fact this method of investigation, made necessary by the most recent discoveries, was almost as new to science as to himself, and it needed perfection on every hand. This first occupied his close attention, and after considerable experimenting he succeeded in producing a simple and inexpensive apparatus that has proved very satisfactory. This apparatus is minutely described and comprehensively figured in the accompanying report. By its use pure cultivations of virus can be carried to almost any number of generations.

The ultimate objects of Dr. Salmon's investigations have been, first, to discover the exact form and nature of the germ causing the diseases under consideration; second, to learn how it is distributed, and how this distribution can be prevented; third, the best methods of destroying the virus within as well as outside of the animal body; fourth, methods of rendering animals insusceptible to the effects of these germs; and, fifth, if it be possible to establish breeds of animals that are insusceptible to such diseases. While these points have not as yet all been solved, his report will be found both interesting and instructive.

Dr. Detmers devoted the greater portion of his time during the past season to experiments with prophylactics, with the hope of discovering a cheap and efficient preventive of swine plague. The results of his experiments, especially with carbolic acid, will prove of great value in those localities where this disease has heretofore been so destructive.

The responses of the correspondents to the circular letter forwarded by the department show that the seat of swine plague has moved southward, and that during the past year it prevailed in a more malignant and destructive form in the States of Missouri, Arkansas, Tennessee, Georgia, Alabama and Virginia than in the States of the Northwest, where it has heretofore prevailed more extensively than elsewhere.

In addition to the reports mentioned above, the attention of the reader is directed to the final report of Dr. Lyman on the subject of contagious pleuro-pneumonia; the results of an investigation of epizootic diseases among both horses and cattle in the State of Illinois; of an outbreak of anthrax among cattle in New Jersey; and brief extracts from letters of correspondents of the department relative to diseases prevailing among domestic animals.

INVESTIGATION OF SWINE PLAGUE, FOWL CHOLERA, AND SOUTHERN CATTLE FEVER.

REPORT OF D. E. SALMON, D. V. M.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: I have the honor to submit the following report of investigations made by me into the nature and character of the diseases known as swine plague, fowl cholera, and southern cattle fever. Before detailing these investigations, however, it seems best to refer at some length to the methods which have been adopted in making them, and to call attention to the results that have been in view. Without such an introduction the reader could scarcely be expected to understand either the value or the objects of the work, and it would appear to him like a haphazard groping in the dark for something which might only exist in imagination. So far from this being the case, I shall endeavor to show that although but a few years ago the investigations of this class of diseases was haphazard work, with scarcely a hope of successful results, this is no longer the case; and to-day we see certain definite results to be obtained—results which seem almost within our grasp, and which must place us in a position to control these diseases in a most perfect manner. Only a year or two ago such a statement would have been regarded as chimerical in the extreme and unworthy of attention, but so great has been the progress of investigation in this direction within that time that it may be safely asserted that at present no well-informed man can be found who would care to contest it.

It has been a great pleasure to the writer to be able to offer evidence for such views in his reports to this department, and it is with the greatest gratification that, whereas but two years ago he could only record his conviction that science would by patient labor eventually master every difficulty connected with the control of these plagues, he is now able to point to the method of inoculation now being practiced on a large scale in France for one of the most destructive of them, and to his method of disinfection and inoculation for another, which is developed in this and the preceding report. The evidence in support of his views is now so steadily accumulating on every hand, however, that there can be no longer reason to doubt the early attainment of his most sanguine expectations.

PART I.—OBJECTS AND METHODS OF INVESTIGATION.

CAUSE OF CONTAGIOUS FEVERS.

It has long been evident that this class of diseases could not be perfectly controlled until we learned their exact cause. That they were due to something from without the body which succeeded in gaining entrance and accomplished the most profound changes in the liquids and various affected organs has been freely admitted; but whether this was "degraded animal bioplasm," a fungus, or a formless ferment, due possibly to the atmospheric condition or to electrical phenomena, were points enveloped in the deepest mystery. And while this mystery remained unsolved we were powerless to advance beyond quarantine and disinfection, and could have no idea of the direction in which to turn for other means of prevention or remedies.

Even the doctrine of a *contagium vivum*, or living contagion, was and is still contested, and such formless ferments as pepsin and diastase are mentioned as examples of bodies which possess the essential properties of contagia. Now, while it may be true that these bodies act simply by contact, and that if we make our solution of them of a certain strength and can remove the products of fermentation as fast as they are formed, an indefinite amount of material may be acted upon without adding to the quantity of ferment, there is still a radical difference between these bodies and the contagia. For instance, we may take one drop of the blood of a fowl that has died of cholera and add it to two thousand times its volume of infusion of the muscles of fowls in a suitable apparatus, and in twenty-four hours the one-thousandth part of a drop of this infusion introduced beneath the skin of a healthy fowl will produce the disease with all its virulence. We may go further, and place one drop of this first cultivation in a second apparatus and again dilute it with two thousand times its bulk of innocent infusion, and in another twenty-four hours our second cultivation will have the same activity as the first, though the one-thousandth part of a drop used for the inoculation would contain but the one four-billionth part of a drop of the original blood. We may continue this dilution under the same conditions, as I have done, to the third, fourth, fifth, or even sixth cultivation, at which time the amount inoculated could contain but the one sixty-four sextillionth part of the drop of the original blood, and still the same virulence remains. There is no doubt, then, that the virus reproduces itself.

What would happen under similar treatment to a solution of diastase or pepsin? Suppose we make a standard solution of one grain of pepsin to the ounce; it may, as I have admitted, transform an indefinite amount of albuminoids into peptones, providing we are able to remove the peptones as soon as formed. Let us take a drop of this standard solution, however, and dilute it two thousand fold, and what is the result? We have at once destroyed the properties of the solution, and these cannot be redeveloped except by evaporating the liquid until the original quantity is obtained, or by adding more of the ferment. And this is just as true of diastase or any other formless ferment with which we are acquainted. In other words, formless ferments are unable to reproduce themselves. Reproduction and multiplication is a function of living matter and of this alone, and when we have proved that virus can be cultivated indefinitely it is equivalent to demonstrating that its essential constituent is a living thing.

PATHOGENIC BACTERIA.

Admitting the cause of contagious diseases to be a living organism, and we have next to inquire into the character of this organism, its morphology, physiology, and place in nature. This, again, was a mooted question for years. Was it living animal matter resembling the leucocytes, or, as it has been called, "degraded bioplasm"? Or was it one or more of the various varieties of fungi? In preceding reports the writer has referred to the brilliant investigations of Dr. Koch, by which he demonstrated the pathogenic action of the *Bacillus anthracis*, a variety of bacteria, in the disease known as charbon.* Later studies of this disease by Pasteur, Toussaint, Greenfield, and others, fully confirm Koch's results, and place the matter, as far as this disease is concerned, beyond doubt. Fowl cholera has also been shown by Pasteur to be due to a form of bacteria, a conclusion which I have been able to confirm by new and very important evidence, as will be seen from the section of this report devoted to that disease.

In those cases in which the cause of contagious fevers has been discovered it has been shown that they are due to a multiplication of bacteria within the living body, and the daily accumulating evidence indicates that the different diseases of this class are all the effects of closely-related organisms. It is to be expected, therefore, that an investigation of contagious diseases must be, to a considerable extent, an investigation of bacteria. In the past it has been quite the fashion to ridicule this class of investigations as visionary, and at best unreliable; but it would seem that the recent and very important discovery by Pasteur of a method of mitigating the activity of a virus by a peculiar method of cultivating the bacteria would be amply sufficient to quiet such ridicule in the future. More than twenty thousand sheep have been rendered insusceptible to charbon during the present year by such attenuated virus, and of the immense number thus inoculated it is questionable if a single accident has occurred. Practical results of the very greatest importance have, therefore, already been attained, and this directly from a study of the bacteria—results which it would have been clearly impossible to accomplish if these organisms had been ignored.

INOCULATION EXPERIMENTS.

The investigation of bacteria to be of any service, however, must go hand in hand with inoculation experiments. We may discover a form of bacteria in the tissues and fluids of the body, and we may be able to cultivate it in a state of purity for an indefinite number of generations, but we are not justified in concluding that it has anything to do with the disease until we have produced unmistakable cases by inoculating with a small quantity of one of these cultivations. Even positive experiments of this nature have not heretofore been considered sufficient evidence to warrant a final conclusion. It must be proved, by a number of tests, that the death of the organism, from various causes, always coincides with the destruction of the activity of the virus. These points must all be brought out by inoculation experiments. And when we come to mitigate the virus, to learn how successful vaccinations can be performed, to test the strength of disinfectants, to bring out the comparative susceptibilities of animals and the methods of rendering them insusceptible, to learn if this insusceptibility can be conferred by heredity upon the offspring, we are powerless to take the first step, or, indeed, any succeeding step, without a continual recurrence to such inoculations.

But such experiments are now classed as "vivisection," and not only in Europe but in America we are met by a set of misguided persons who, not content with manufacturing public sentiment against vivisection and the vivisector, are asking for laws to practically stop such investigations. In the name of humanity they ask that not only the mil-

* The writer has discussed this question at greater length in articles entitled "Charbon and the Germ Theory of Disease," *American Monthly Microscopical Journal*, 1881, pp. 61–81.

lions of animals scattered over the world, but that mankind as well, shall be condemned to suffer decimation from contagious plagues for yet untold generations, simply because in order to learn how to prevent such scourges we must sacrifice a few hundreds or thousands of animals, which at the best are destined to be slaughtered to satisfy our carnivorous appetites. It is not my purpose to enlarge upon this topic in the present report, and I should not have mentioned it but for the fact that in enlightened England the absurdity has lately been committed of tying the hands of some of their ablest investigators by an enactment of this character; and, as the investigation of these diseases so completely depends upon this method of research, it seems a favorable time for calling attention to its importance.

EXAMINATION OF LIQUIDS FOR BACTERIA.

The search for disease germs or pathogenic bacteria in the liquids and solids of the body is, in spite of the many recent and improved methods of investigation, extremely difficult and unsatisfactory. Whether they are less numerous than we should expect, whether their reaction to staining agents differs from that observed with septic bacteria, or whether the characters of the liquid surrounding them should be accepted as the cause of this difficulty, I am not prepared to decide. But certain it is that even in fowl cholera, which is undoubtedly due to bacteria, one may examine many preparations of blood or tissues, stained or unstained, without being able to discover what he can unhesitatingly accept as these organisms. When we come to the examination of properly-prepared cultivation liquids the difficulties vanish, and there is no longer reason for either doubt or uncertainty. Preparations may be examined, stained or unstained, and with a good lens, giving a power of seven hundred to one thousand diameters, the bacteria are clearly shown.

To stain the bacteria the method devised by Koch has been found to give by far the best results. A drop of the liquid is placed upon the slide and spread to a uniform thickness; it is then rapidly dried over the lamp and a drop or two of a solution of aniline violet, two grains to the ounce, is applied and immediately washed away with a stream of distilled water. The slide is again dried, a drop of pure Canada balsam is applied to the cover-glass, and this is inverted over the preparation. At this time, if we are dealing with a cultivation liquid, it may be impossible to detect with the unassisted eye even a trace of violet coloring, and yet on examination with a sufficient power the organisms will be found to be perfectly stained. In the case of blood the staining is only too apparent, and the statement made by some observers that only bacteria take this color, and that it may be considered as a method of determining the nature of small particles for this reason, has not been borne out in my work. The nuclei of the red corpuscles of birds stain deeply, and in case an attempt is made to "fix" the preparation with osmic acid the constituents of the plasma are coagulated, assume a granular form, and when stained the appearance is that of a zoöglœa cluster of micrococci. In the blood of fowl cholera it has often proved extremely difficult to render the bacteria visible, while with the blood of swine plague sent me by Professor Law the micrococci could be seen in both stained and unstained preparations to the greatest satisfaction.

EXAMINATION OF TISSUES FOR BACTERIA.

Some microscopists have been successful by placing pieces of the tissues in alcohol for twenty-four hours, then imbedding in a rather soft mixture and cutting the sections in a microtome. The sections thus obtained are placed for half an hour in a staining fluid composed of half a grain of aniline violet in an ounce of distilled water; they are then placed for two minutes in dilute acetic acid (4 minims to the ounce), then for one minute in ordinary alcohol, then for one minute in absolute alcohol, finally for two minutes in oil of cloves, when they are mounted in Canada balsam.*

The difficulty of making sections with such imperfectly hardened specimens has led me to use a longer process of hardening with chromic acid, one-fifth of one per cent., and alcohol, equal parts, the results being, so far as I can judge at present, identical. In neither case, however, has the success been very flattering.

For the examination of the preparations I have used a one-tenth and one-fifteenth inch water immersion, objective, and a one-fifteenth homogeneous immersion, all by Tolles, in connection with an Abbe-Zeiss illuminating apparatus. These appliances therefore represent the utmost perfection of the day, while the methods used are those which have given the best results in similar investigations; and if the examinations have not been as satisfactory as could be desired it is probably due to the inherent difficulty of the subject and to the fact that our methods may still be improved.

KEEPING DISTILLED WATER FREE FROM BACTERIA.

In this class of investigations it is absolutely necessary to use distilled water; we need it for our immersion lenses, to make staining and hardening solutions, to dissolve and dilute reagents, and for many other purposes. But even distilled water, as I have shown in a preceding report, very soon teems with immense numbers of bacteria, organisms which at present we have no means of distinguishing from those which are the active cause of some of the contagious diseases. It is plain, therefore, that if we use distilled water swarming with bacteria in our hardening or staining solutions, if it constitutes a part of the reagents that we use upon our preparations, or even if it is used to make cultivation liquids, these innocent organisms may be mistaken for pathogenic ones, and our conclusions will be entirely without value.

To guard against such errors I have devised the apparatus illustrated in Plate II, Fig. 2. The flask A, after thorough cleaning, is filled by filtering into it freshly distilled water, and the soft rubber cork, through which pass the tubes B and C, is tightly adjusted. The tube B does not reach the water in the flask, but is designed for admitting filtered air, and is packed for two or three inches from the external orifice with cotton wool, while the tube C, which acts as a siphon, reaches to the bottom of the flask and terminates externally in a piece of caoutchouc tubing, D, on which is placed the compressor E, and into which fits the terminal tube F. The whole may be kept for several hours before filling, at a temperature of 220° to 225°F., to kill all germs which may be lodged in the cotton-filter or the tubes. The distilled water, after being placed in this apparatus, is boiled two or three times at intervals of a few hours, care being taken to keep the filter from becoming wet by condensation of steam, a precaution which I have found necessary to the value of such a filter, and just at the end of the last boiling the compressor is opened, and if necessary the ventilating tube is closed until the pressure of the steam has forced the water to fill the siphon. The com-

*Alexander Ogston, M. D. Report on Micro-organisms in Surgical Diseases, *British Medical Journal*, 1881, p. 369.

pressor is now closed, the ventilating tube opened, and the apparatus is ready for use. Of course, whenever the compressor is opened, water flows from the flask, and if the small quantity which has been in the terminal tube is rejected the remainder will be found free from contamination with such organisms.

PREPARING ANILINE STAINING FLUID.

For this purpose a solution of the aniline violet is made in strong alcohol of such a strength that each drop contains one-sixteenth of a grain of the coloring matter, and in this form may be preserved convenient for use at any time. When some sections are to be stained one drop of this is placed in a drachm of pure distilled water, and this is at once filtered and used; this makes the solution of half a grain to the ounce. For the stronger solution four drops are required to each drachm of distilled water. In this way is obtained a solution free from bacteria and giving results worthy of confidence; but if this aqueous solution is allowed to stand a few hours the development of these organisms commences and it is no longer fit for use. If those who investigate these diseases persist in using old aqueous solutions of aniline, or even aniline inks for their staining fluids, they must not expect very much reliance to be placed in the accuracy of their results.

THE CULTIVATION OF BACTERIA.

In the preceding report a form of apparatus was described for making such cultivations, but this was soon found too complicated for the purposes of investigation. A simple apparatus was needed, provided with a ventilating tube packed with cotton, which would take but little space in the incubator, that could be made, if need be, in the most primitive laboratory, that could be easily filled with the cultivating fluid, and when sterilized might be preserved for use at any time, the contents being readily accessible for inoculation and for removal, either for examination, for producing other cultivations, or for inoculation experiments, and all with the least possible chance of admitting the germs of bacteria continually floating in the atmosphere. After several months experimenting the apparatus shown in Plate I, Fig. 1, was settled upon as satisfactorily filling these conditions. It consists of a test-tube five inches long and three-fourths of an inch in diameter, and in the one case is closed with a rubber cork pierced with a single hole, and in the other the tube is drawn down near its upper extremity to one-fourth of an inch in diameter. In the rubber cork is placed a piece of glass tube one-fourth of an inch in diameter that just reaches the lower end of the cork, but projects three-fourths of an inch above the upper end, on which is placed a close-fitting piece of caoutchouc tubing one inch in length, into which, again, fits the bent-glass tube D, the external part being packed with cotton-wool as a filter. The adjustable ventilating tube is arranged in a similar manner in the second form of apparatus.

These tubes are about half-filled with the cultivation liquid and are then then placed in a vessel that contains three or four inches of water, Plate XI, Fig. 16, that can be tightly covered, in which they are boiled three or four times at intervals of a few hours. In this way the whole apparatus, including the ventilating tube and its cotton filter, is subjected to the heat of boiling water, or to steam of the same temperature. A sterilizing apparatus arranged for heating the tubes in a receptacle surrounded by boiling water, a section of which is shown in Plate XI, Fig. 17, has not given as good results as the simpler method of placing them directly in the hot water and allowing the steam to come in actual contact with the parts out of the water.

Notwithstanding the frequent assertions of experimenters that cultivation liquids may be easily sterilized, and that boiling for five minutes is sufficient for this, I have been forced to the conclusion that the perfect sterilization of such liquids is frequently attended with serious difficulty. On one occasion twenty cultivation tubes were boiled four times at intervals of a few hours, each boiling being continued for ten to fifteen minutes, in the vessel shown in Plate XI, Fig. 16. Unfortunately, after the last heating, the lid was removed and not replaced; the cold air coming in contact with the ventilating tubes condensed the vapor in the filters, and as a result every tube became infected with atmospheric bacteria, and was turbid with them within three days.

Again, while at Atlanta investigating the Southern cattle fever, the sterilizing apparatus, shown in section in Plate XI, Fig. 17, was used; it consists of an inner compartment surrounded by boiling water and steam, and covered with a double lid having an air space of two inches. The cultivation tubes were but a degree or two below the boiling point as determined by actual test, and to illustrate the difficulty of sterilizing them I transcribe the following record from my note-book. In all cases the tubes were allowed to remain in the apparatus till cold, thus subjecting them to a high temperature for a much longer time than is indicated by the actual duration of the boiling:

July 20, 5 *p. m.*—Nineteen cultivation tubes were filled with infusion of beef, placed in the apparatus, and the water boiled for ten minutes.

July 21, 9 *a. m.*—A few tubes, on careful inspection, indicate the very beginning of turbidity. They were all placed in the apparatus and this heated to boiling for ten minutes, and this boiling repeated at 5 p. m.

July 22.—The apparatus boiled morning and evening the same as yesterday.

July 23.—Boiled once, being six times in all.

July 27.—Seven of the tubes are turbid; the remainder are placed in the apparatus, and this again boiled for ten minutes.

August 1.—But six tubes remain free from bacteria. Most of the affected ones have but a slight bacterial membrane on the surface, while the liquid beneath is nearly as transparent as formerly. The bacterium which thus resists heat is a *Bacillus*, somewhat peculiar in its characters, as it divides into shorter members than the *B. subtilis*. It is about $\frac{1}{30000}$th of an inch in diameter, and divides into rods $\frac{1}{6000}$th to $\frac{1}{8000}$th of an inch in length, many of these subdividing into members $\frac{1}{12000}$th to $\frac{1}{16000}$th of an inch long, and then closely resemble *Bacterium termo*. The spores seem to be spherical particles $\frac{1}{50000}$th of an inch in diameter.

August 5.—Thirteen tubes filled to-day with fresh infusion of beef. They were placed in the apparatus, which was boiled for ten minutes at noon and for fifteen minutes at six o'clock.

August 6.—Every tube is turbid with bacteria. Thirteen tubes were now filled with fresh infusion, neutralized with liquor potassæ. They are placed in the apparatus, which is boiled from 11 to 11.30 a. m., and again from 4.30 to 6.30 p. m.

August 7.—The apparatus boiled from 9 to 10 a. m.

August 8.—The apparatus boiled an hour in the morning and another hour in the evening.

August 9.—Boiled an hour in the morning.

August 11.—Five of the tubes are turbid with bacteria; the remainder returned to the apparatus and boiled.

August 15.—Two more tubes are turbid.

I have been somewhat at a loss to account satisfactorily for the extreme difficulty of sterilizing the tubes in these cases. I am certain it was not due to atmospheric infection after sterilization, for particular attention was given to the condition of the ventilating filters, and hundreds of such tubes have been preserved for an indefinite time, on other occasions, after sterilization without becoming infected. It is possible that the extreme drought had something to do with this extraordinary resistance to heat. It is well known, for instance, that the germs of the hay bacillus when obtained from dry hay withstand several hours' boiling, while, when fresh and moist, they are destroyed in as many minutes. Professor Tyndall, I believe, has explained this by supposing that the perfectly dry spores do not readily imbibe water, and are not moistened for several hours after being placed therein, and while dry they are not destroyed by the heat of boiling water.

Whatever the explanation may be, it is a new illustration of the fact that a few minutes' boiling cannot be relied upon to sterilize such liquids, and that unless our cultivation liquids are preserved at 100°F. a sufficient time before use to prove that they contain no atmospheric germs, the results are at best untrustworthy.

MANNER OF USING THE CULTIVATION APPARATUS.

The cultivation liquid is made by infusing the muscles of various animals in distilled water at a temperature of 150° to 160°F. for two or three hours, then boiling and filtering. The liquid thus obtained should be as limpid and colorless as the purest water. The cultivation tubes are half filled with this, previously neutralized with caustic potash, and sterilized as already described. The blood for inoculation is either obtained directly from the veins by means of vacuum tubes, as described in my preceding report, or when convenient the heart is opened by a knife, freed from germs by passing it through the flame of a lamp, a piece of capillary glass tubing drawn to $\frac{1}{25}$th of an inch in diameter and one-half to three-fourths of an inch long (Plate XI, Fig. 18), is taken up with flamed forceps, passed through the flame itself, and touched to the blood in the heart, with which it immediately fills by capillarity. The ventilating tube of the cultivation apparatus is now passed through the flame and removed, and the bit of capillary tube containing the blood is dropped through the opening into the liquid. The ventilating tube is again flamed and replaced and the apparatus placed in an incubator at 100° F.

The multiplication of germs becomes apparent from the turbidity of the liquid in about twenty hours. To examine this liquid without contaminating it with germs from the atmosphere, a capillary pipette is made by drawing a long and fine projection to an ordinary glass tube, as shown in Plate XI, Fig. 15, the end being sealed. The external part of the body of the tube is packed with cotton wool, and the whole is then baked for several hours at a temperature of 230°F. to destroy all germs. Now, to obtain a sample of the cultivation liquid, a small caoutchouc bulb is adjusted as in the figure, the point of the pipette is broken, the ventilating tube is removed with the precautions already mentioned, the pipette is flamed and passed beneath the surface of the liquid, when the bulb is compressed to expel a small quantity of the pure air which it contains, and the liquid which takes the place of this, as the bulb resumes its original form, is removed in the pipette and can be used for microscopical examination, for inoculating animals, or for starting new cultivations.

It sometimes happens that in spite of all precautions our cultivations are impure; we can plainly see that there are two forms of organisms. One grows at the bottom of our cultivation liquid while the other occupies the surface, where it forms a covering membrane; one is motionless while the other swims with the plainest undulations or gyrations; one may be spherical or oval while the other is rod-shapped. It has been common to speak of these different forms as but stages in the existence of the same organism; but a study of their life history has not justified this view, and we are now satisfied that such appearances indicate contamination of our cultivations with some of the countless germs continually floating in the air.

Sometimes it is very desirable to get rid of these foreign germs and obtain a pure cultivation from an impure one. Is this possible? At one time it was supposed that it might be accomplished by continuous cultivations, but experiment demonstrated that usually the different organisms retained their relative proportion to each other through an indefinite number of cultivations. Lately Buchner has suggested a practical plan which may be carried out very successfully with the apparatus of my invention described above.

The organisms from the atmosphere in all well-made cultivations are less numerous than the disease germs, and above all they are found more particularly at the surface, while the latter prefer to grow in the deeper layers of the liquid. A drop of the cultivation liquid is taken from near the bottom of the tube, with suitable precautions, and placed in another apparatus as if for a fresh cultivation; this is at once agitated to diffuse the drop equally through the whole. Now a drop is taken at once from this and placed in a third apparatus, and from the third a drop is placed in a fourth for cultivation. The drop taken from the second apparatus contains $\frac{1}{5000}$th of a drop taken from the first, and that from the third contains but $\frac{1}{250000}$th of the first drop. Now, if a drop of the first cultivation contained 500,000 disease germs and 50,000 septic germs, it is plain that every drop of the second dilution would contain two of the former, while there would only be one of the latter to every five drops. If the number of germs is greater, as is generally the case, we have only to resort to a third dilution and vary the quantity of the diluting liquid to suit our case, and by starting a number of cultivations from this we will get some in which the organism exists in perfect purity.

ULTIMATE OBJECTS OF SUCH INVESTIGATIONS.

Of course our first endeavor by cultivation experiments is to isolate the contagious germs to determine their form, manner of growth, and multiplication; to learn their place in nature; the conditions which are favorable and unfavorable to them. But science of to-day is too practical to stop here—we must have results which will enable us to control the contagious plagues more perfectly than heretofore. In the first place we must know how these germs are distributed; in what manner they leave the sick animal; whether they are carried by currents of air; how and for what time they are preserved on or within the soil or in stables; and in what manner they find their way into the bodies of healthy animals.

When our information is satisfactory on these points, we are in a position to inquire how such germs may be destroyed, the chemical agents which are most efficient for this purpose, the strength in which they are to be employed, and the effect of ventilation and of plowing or burning infected pastures.

Having learned what is possible in regard to the contagious germ, we next turn our attention to the animals liable to be affected. We find that a certain number are insusceptible to the effects of the virus; they occupy the same stables or fields with the sick, take their food and drink in common, breathe a contaminated air, and even resist inoculations with the most potent virus. In what does this insusceptibility consist? How was it obtained? How can it be conferred upon other animals? For what length of time will it protect them? And is it transmitted in any extent by hereditary influence to the offspring? Potent questions are these, which, when properly answered, must place the control of animal plagues fully within our grasp; and not of animal plagues alone, for are not some of these common to both mankind and animals? And is it too much to believe that, when the contagious diseases of animals are fully understood and controlled, the millions of human beings who are now carried to untimely graves by allied plagues may be spared?

These are the hopes that actuate us, nay they are the convictions which grow stronger with each experiment. But a few short years ago this great field for research, which we now see before and around us, might be compared to one of those forests situated in a rich, moist, alluvial region of the tropics. On every hand immense trees, through the foliage of which scarcely a ray of light could penetrate, while below are briars, vines, and various kinds of impenetrable undergrowth. Not a path to guide the steps—all a hopeless wilderness. To-day how changed. Roads have been made by which the wilderness is traversed—are not the experimental methods of inoculation and cultivation of virus now followed with such success worthy of the name? And light is streaming through the overhanging canopy all around us until our forest is scarcely more than a grove. It is the result of the recent studies of contagia, their manner of distribution, the methods by which they may be attenuated and made to produce insusceptibility instead of death, their conversion from enemies to allies. It is no longer a question of possibility if this grove shall give place to the fertile cultivated field—it is simply a question of the time necessary to produce this change.

PART II.—INVESTIGATIONS OF SWINE PLAGUE.

The researches in regard to this disease, which were detailed in my report for 1880, having all pointed to a micrococcus as its cause rather than to a bacillus, as maintained by Drs. Klein and Detmers, I determined to make one more attempt to obtain satisfactory evidence on this point. I therefore requested Professor Law to send me some genuine swine-plague virus, as he was then experimenting with this disease. In answer to this he sent me, among other pathological products, a capillary tube containing blood "collected from ear veins, near a blue slough, of a pig that had been infected by exposure and inoculation."

This was taken by Professor Law December 14, 1880, and examined by me December 21. The blood in the tube was studied with the greatest care, the slides and everything coming in contact with it being well flamed. It was examined fresh from the tube, and also in preparations made by drying on the cover glass, and tinting with aniline, the results being in each case the same. Very many micrococci were to be seen perfectly distinct in outline; they existed in clusters, short chains and singly, and the appearance was so characteristic as not to leave a shadow of doubt in regard to their nature. No other form of bacteria was to be discovered.

At the same time Professor Law sent me blood from the portal vein of a pig that had been suffocated, as he thought at the time that this might be a method of originating the contagious affection under investigation. This also contained bacteria of a single variety, but it was the *Bacterium termo*, and the contrast between these and the micrococci was too plain to be mistaken. These organisms were all elliptical in form and mostly existed in pairs, swimming about in all directions in the most lively manner. The micrococci on the other hand have no movement except that called molecular. Although Professor Law wrote me when sending the virus that he had inoculated a pig with the blood from the suffocated animal, and that this subject already had elevated temperature, I predicted when stating the result of my examinations that he would not obtain a case of genuine swine plague from such blood, and this, he was kind enough to inform me later, proved to be the fact.

As a more complete test of the nature of the bodies in the swine-plague virus, two cultivation slides were prepared by cementing upon them a deep glass cell. A drop of neutral infusion of beef well sterilized was placed on a thin cover glass and a small particle of the virus added when it was inverted over the cell and cemented with paraffine. The slides were then kept in the incubator at 100°F. These cultivations were not successful; the micrococci did not multiply in either case.

At the same time that the cultivation slides were prepared two of my cultivation tubes already described, containing one ounce each of the same sterilized infusion of beef, were inoculated by dropping into the liquid a particle of wire that was first flamed and touched to the blood. By way of contrast a third tube was inoculated in the same way with fresh human blood. All were placed in the incubator at 100° F. The next day (December 29) the contents of the tubes inoculated with the virus were no longer transparent but turbid, while that charged with human blood was unchanged. The cultivations were found to owe their turbidity to immense numbers of the micrococci in clusters and chains as in the virulent blood, but the most careful examination did not reveal a single bacillus or any other form whatever.

During the very cold night which followed, there being no heat under the incubator, these cultivations were frozen solid, and as it was desirable to test the resistance of this organism to freezing I inoculated another cultivation tube from one of these as soon as thawed. In twelve hours this tube was as turbid as the other and contained only the same organism. The vitality, therefore, did not seem in the least impaired by freezing.

By January 17, 1881, I had carried these cultivations to the sixth generation without any contamination with atmospheric bacteria, as may be seen by reference to Plate V, Fig. 5. At this date I inoculated a pig by injecting under the skin of the inside of the thigh, with a hypodermic syringe, a drachm of the sixth cultivation; and a second animal was inoculated in the same manner with the first cultivation. It is here worthy of remark that the drachm of the sixth cultivation must have contained less than the one-quintillionth part of a drop of the original blood. The results of these inoculations are shown in the following tables:

PIG No. 1.—*Inoculated with sixth cultivation of virus.*

Date.	Hour, a. m.	Atmosphere temperature.	Body temperature.	Remarks.
1881.		°F.	°F.	
January 17	11	55	100 1/5	Hypodermic injection of one drachm of virus
18	11	48	99 1/5	Hard swelling at point of inoculation.
19	10.15	44	102 1/5	
20	9.45	46	103 3/5	Swelling gradually disappearing.
21	9.45	36	100 1/5	
22	10	32	102	
23	11	30	102 3/5	Blush on the skin.
24	10	32	99 3/5	Slight eruption.
25	10.45	30	102 1/5	
26	9.45	30	101 1/5	
27	9.30	22	102 1/5	
28	11.45	36	103 1/5	
29	10.30	36	103 3/5	Plain eruption.
30	10.30	48	102	
31	10	50	102 3/5	
February 1	9.30	53	103	
2	11	36	102 1/5	Well.

PIG No. 2.—*Inoculated with first cultivation of virus.*

Date.		Hour, a. m.	Atmosphere temperature.	Body temperature.	Remarks.
1881.			°F.	°F.	
January	17	11	55	101	Hypodermic injection of one drachm of virus.
	18	11	48	101 3/5	Swelling at point of inoculation.
	19	10.15	44	102 4/5	Swelling much reduced.
	20	9.45	46	102 1/5	
	21	9.45	36	99 1/5	
	22	10	32	101 3/5	
	23	11	30	102	Blush on skin.
	24	10	32	101 4/5	Several papules on skin of abdomen.
	25	10.45	30	103 1/5	
	26	9.45	30	103 2/5	Large elevations on skin.
	27	9.30	22	102 3/5	
	28	11.45	36	104	
	29	10.30	36	104	Eruption covers the body.
	30	10.30	48	103	
	31	10	50	103 2/5	
February	1	9.30	53	103 1/5	
	2	11	36	102 4/5	Well.

The eruption in both cases was very marked. It commenced with a red blush or congestion of the skin, followed by flat elevations one-half to three-fourths of an inch in diameter. The epidermis on these became dry and exfoliated, leaving a red, congested spot, not moist or granulating, but already healed. These elevations were scattered over the whole body, and were smaller on No. 1, though equally numerous. A similar eruption being an almost constant attendant of the severe forms of swine plague, I think there can be no doubt that these were mild cases. I regret, however, that the animals were not slaughtered for *post-mortem* examination, though it was believed that no satisfactory lesions of internal organs would be found when the general health was so good. At any rate I insist that the eruption appeared after the average incubation of swine plague, and that it was sufficient to characterize a mild attack of the disease.

If this is admitted it follows that the organism of swine plague is not a bacillus but a micrococcus. And it also follows that since this organism was carried through six successive cultivations without changing its form the granules are not bacillus spores, and that they do not develop into rods of any variety whatever.

Drs. Klein and Detmers have insisted, however, that the organism was a bacillus, and the latter still maintains that the spherical granules are simply its spores. In my former report I gave my reasons for believing that the *bacilli* of these gentlemen were septic bacteria that had gained entrance to their liquids from the atmosphere, but the statement of Dr. Klein being now generally accepted by scientists that he has produced the disease by inoculation with the eighth pure cultivation of a bacillus, it seems necessary to call attention to some particulars not generally known in regard to these experiments.

1. *The cultivation apparatus could not be sterilized.*—Dr. Klein's cultivation apparatus was made by cementing a cell on a glass slide, then inverting over this a thin cover on which was a drop of aqueous humor inoculated with the virus. The thin cover was kept in place by a ring of olive oil. Now I have found from experience that it is very difficult to heat such a slide sufficient to destroy the atmospheric germs adhering to it without destroying the cement which holds the cell in place; it is also difficult to heat the thin covers without warping or breaking them.

Even with this successfully performed, there is the air which is continually changing in the cell, and the aqueous humor which must remain on the thin cover, fully exposed to the air, while the inoculation is performed, and must then be inverted. The apparatus is not one from which we should expect conclusive results even were a sterilization attempted, which does not seem to have been the case.

2. *The cultivations were not made in a sterilized fluid.*—The cultivation liquid in these experiments was aqueous humor from the eye of a rabbit. In my previous report I have given the evidence which seems to show that the liquids and organs of healthy animals may contain the germs of bacteria; at least this is still a contested point, with the preponderance of evidence favoring the affirmative view. But leaving this out of the question I am satisfied that any one who has experimented on such matters must be convinced of the impossibility of taking a drop of aqueous humor from a rabbit's eye, placing this on a cover glass fully exposed to the air, inoculating, and then inverting over a cell without contamination with atmospheric bacteria.

3. *The conditions of the cultivations were unfavorable to pathogenic bacteria.*—If we cultivate the *Bacillus anthracis*, the micrococcus of fowl cholera, or that of swine plague in the cultivation tubes which I have described, a careful inspection will convince us that they commence their growth in the deeper parts of the liquid, and that the turbidity scarcely reaches the surface of the liquid when the cultivation is finished. On the other hand, if we cultivate the *Bacillus subtilis*, the *Bacterium termo*, or any other atmospheric bacteria, the turbidity commences at the surface of the cultivation and extends downward, and with some *bacilli* it does not extend one-eighth of an inch. My latest researches have convinced me that the known pathogenic bacteria never form a membrane on the surface, while this is the rule with the septic forms. In other words, the bacteria liable to contaminate our cultivations flourish best in contact with the air, while the pathogenic forms are at the best when protected from such direct contact. If now we make a cultivation in a single drop of liquid fully exposed to the air, it is not surprising if the atmospheric bacteria obtain the advantage and multiply while the pathogenic forms are destroyed. This may also explain my failure to cultivate the micrococcus of swine plague in an apparatus similar to Klein's, while I succeeded admirably with the tubes.

It may be asked if this is a rule that will infallibly distinguish the pathogenic from the septic bacteria; and in regard to this we are unprepared to answer, but it may be accepted from what is already known that the pathogenic forms will not at once flourish if cultivated in contact with the air. The *Bacillus subtilis*, when cultivated in infusions, multiplies near the surface and there forms a thick membrane; but before Buchner succeeded in converting it into the *Bacillus anthracis* he was obliged to grow it in an apparatus that was continually agitated, and in which it could not remain at the surface. So when the converse change is made the *Bacillus anthracis*, from growing at the bottom of solutions comes to grow at the surface, and is then harmless. In other words, before the atmospheric bacteria can multiply within the animal body they must be gradually adapted to the conditions which they meet there, the most important of which seems to be the restricted amount of available oxygen. And so when we are told that his cultivations in tubes had a membrane on the surface, it is for us a very strong indication that this membrane was formed by harmless bacteria that had gained entrance from the atmosphere.

It is true that in my last report I described the organism of fowl cholera as forming a slight membrane at the surface of the cultivations, but a vast number of cultivations made in the improved apparatus described in this report have taught me that this membrane only occurs in cases of contamination, and is due to the prolification of bacteria that have grown for a considerable number of generations in contact with the air.

4. *The inoculations did not give positive results.*—To decide a contested point of so much importance it cannot be too much to expect satisfactory results from the inoculation experiments. There might be a difference of opinion as to what are the pathognomonic characters of the affection, but if there was loss of appetite, marked discoloration or eruption on the skin, ulceration of the bowels, or inflammation of the lungs, we should be satisfied as to the production of the disease. But when we are told that the three animals inoculated with the eighth cultivation showed no symptoms of the disease during life, and that it was only at the *post-mortem* examination after slaughter that signs of the disease were found, we are not convinced that these equivocal signs resulted from the inoculation. We have seen too many enlarged and reddened lymphatic glands, too many appearances of slight congestion in various organs of healthy pigs, to accept these as a criterion of the disease.

5. *Klein found the micrococci, not the bacilli, in the tissues.*—In his first communication on this subject Dr. Klein wrote as follows:

From and even before the first signs of necrosis of the mucosa [of intestine], viz., when the epithelium begins to break down and be shed from the surface, there are found masses of micrococci, which in some ulcers occupy a great portion of the *débris*.

Again, he says:

In the ulceration of the tongue just mentioned, and at a time when the superficial scab has not become removed, I have seen masses of micrococci situate chiefly in the tissue of the papillæ, but in some places reaching so far deep as the inflammation extends. That they are micrococci was proved by their forming lumps of uniform granules. These lumps stain deep purple-blue in hæmatoxylon, and are thus very conspicuous, and besides resist the action of caustic potash, with which all the rest of the tissue disappears. These heaps of micrococci in locality correspond to the papillæ, and are on the surface of the scab, but underneath the covering epithelium, some parts of this having changed into a dry, hard, discolored mass, others containing larger or smaller vesicles filled with fluid.

More than this, he found the lymphatic vessels of the mucous membrane of the epiglottis filled with micrococci; and in the last stages of the lobular pneumonia, in the infiltrated, firm, more or less disintegrating parts, he found—

Great masses of micrococci, filling up capillaries and veins, and also contained in lymphatics around arteries. The pleura is much swollen and contains great numbers —continuous layers of lumps of micrococci. The free surface of the membrane is in many parts covered with them.*

In spite of all this, after Koch's investigations of the *Bacillus anthracis* became better known, and a theory was promulgated in certain quarters that all pathogenic bacteria belonged to the genus *bacillus*, he seems to have made his cultivation and inoculation experiments just referred to, and to have then concluded the disease was caused by *bacilli*. But he had not yet entirely discarded the micrococci, for we find in his article contributed to the Quarterly Journal of Microscopical Sciences (April, 1878) the following:

At first I misinterpreted the spores, regarding them as micrococci, and only after repeated observations have I succeeded in tracing them through their different stages of development.

*Dr. Klein. The so-called enteric, or typhod fever of the pig.—*Veterinary Journal*, 1877, Vol. V, pp. 126–129.

Finally, we are led to the conclusion that he discards the micrococci entirely, since in his last article on the subject, the original of which I have not yet been able to obtain, he speaks of his cultivations of *bacillus* from the pulmonal liquid as always failing, from the great development of micrococci. Indeed, it is difficult to conceive how he could long confound the micrococci with the spores of his *bacillus*, since the former are much larger, are spherical instead of cylindrical, multiply in the form of clusters and chains, and never develop into filaments. It seems to me, therefore, that a consideration of Dr. Klein's observations, even by themselves, is not sufficient to indicate at all satisfactorily the pathogenic action of his *bacillus*.

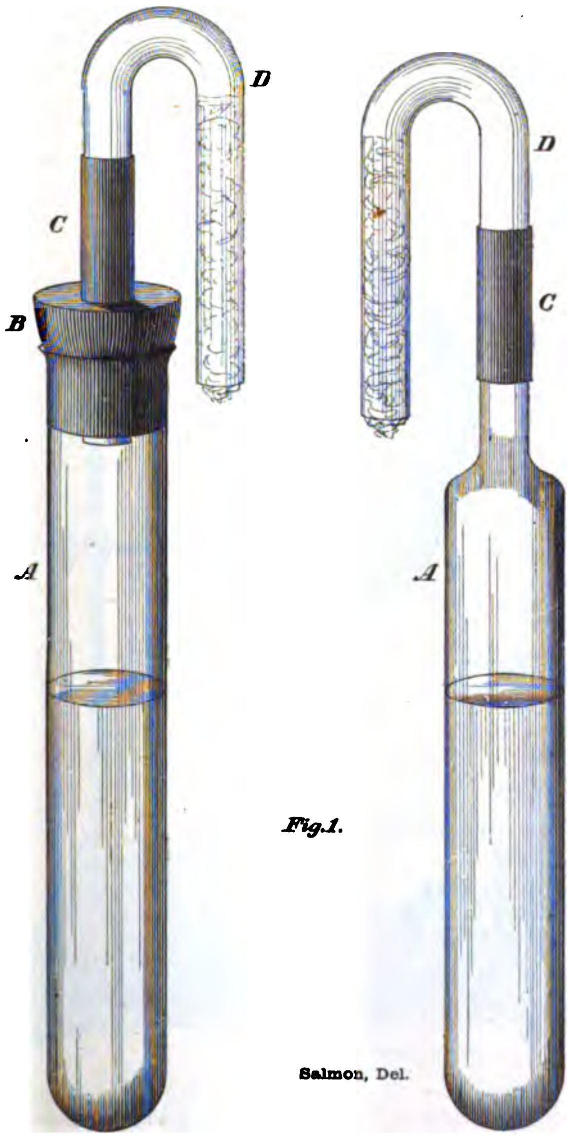
And when we add to this the facts that all observers have been struck with the number and the prominence of the micrococci; that these have alone been found in the blood and inflammatory liquids obtained by me at different outbreaks in vacuum tubes without coming into contact with the air; that these micrococci cultivated in purity to the sixth generation in relatively large quantities of liquid produced, after the average period of incubation (seven to twelve days), the unmistakable eruption of swine plague, it seems to me that they must be accepted as the pathogenic agent.

I am led to insist upon this point because in two cases of pork poisoning which recently occurred in England a *bacillus* was found by Dr. Klein in the meat, and the suggestion soon followed from other parties that this might be the *bacillus* of swine plague, or, if not, that this latter was probably equally dangerous, and hence another reason for prohibiting American pork. In this case the pork was fortunately raised and slaughtered in England, and what is equally significant it was unsalted. The pig had been healthy and the meat was contaminated, without doubt, by the water used in washing it or by the butcher's instruments; and the organism, instead of being the *bacillus* of swine plague, was probably the septic vibrio discovered by Pasteur.

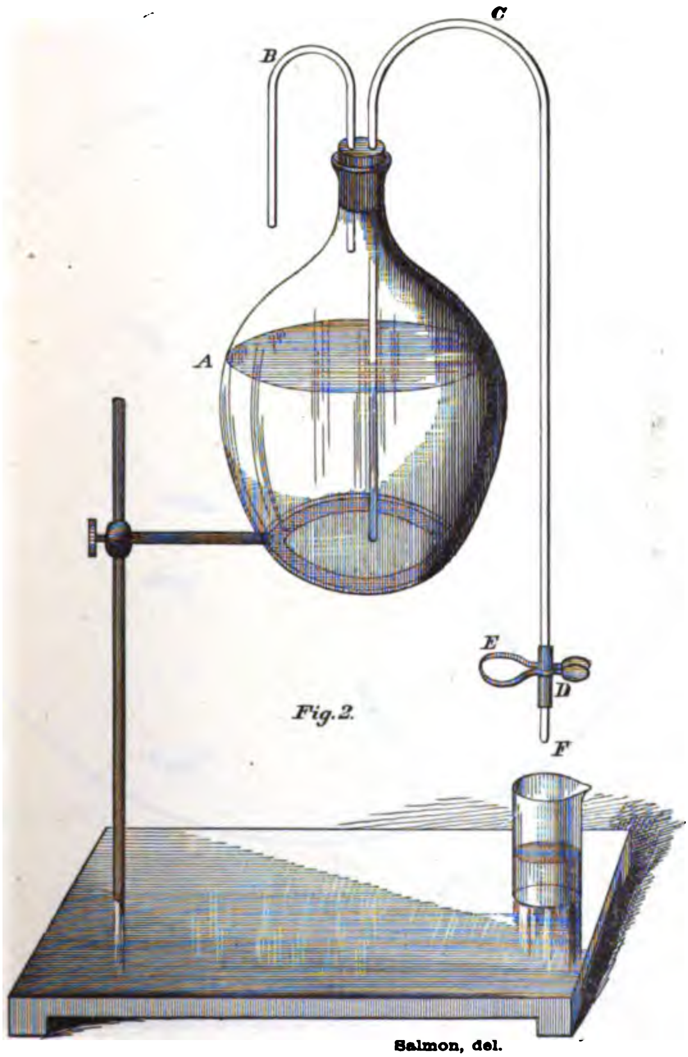
PART III.—INVESTIGATIONS OF FOWL CHOLERA.

VIRUS NOT DIFFUSIBLE.

In my preceding report a certain amount of evidence was presented to show that the virus of this disease is not diffusible through the air; but in regard to this there might still be a reasonable feeling of doubt, owing to the fact that the experiments had been conducted in the open air and were, perhaps, insufficient in number. Since that report was written my experiments have been conducted in a building 10 by 50 feet, in which the experimental coops have not been farther than four or five feet from each other. In this building there were coops of sick fowls continuously for months, while in alternate coops were well ones. At night the doors and windows were all closed. There being from twelve to twenty healthy and susceptible fowls and an equal number of sick ones at a time, we have here the best conditions for transmission of the disease by the atmosphere; and yet, during fully six months of such experiments, there has not been a single case in which there could be the least suspicion that the malady was contracted in this manner. We may safely conclude, therefore, that this virus is fixed and not diffusible, and that in all cases where the disease originates the virus is carried in some tangible form and introduced into the bodies of the healthy fowls by way of the digestive organs.

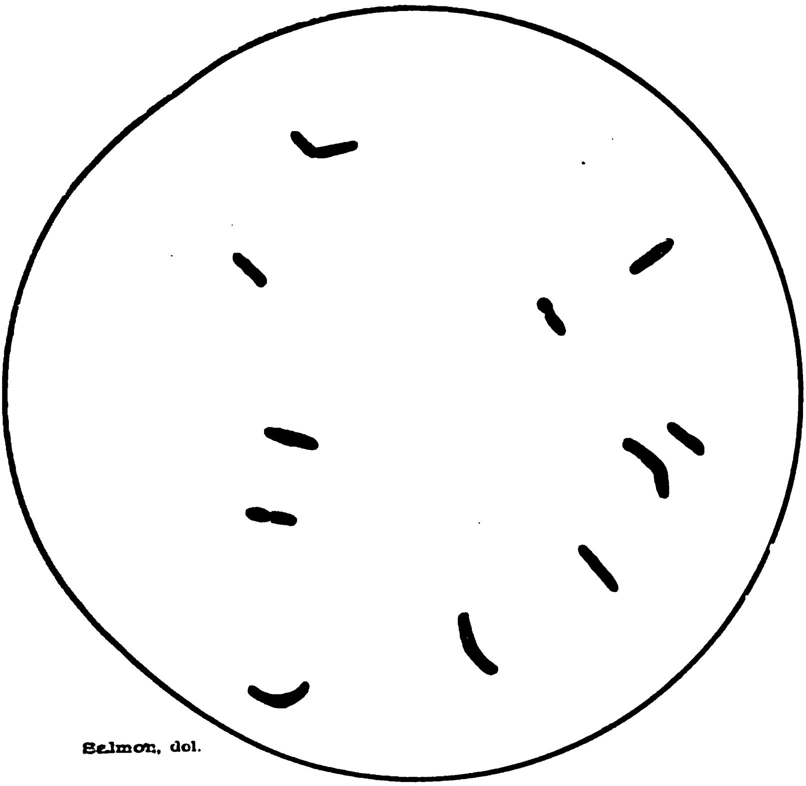


Cultivation Apparatus: A, test tube; B, soft rubber cork; C, caoutchouc connection; D, ventilating tube packed with cotton.



Salmon, del.

Apparatus for pure distilled water. A, flask; B, ventilating tube packed with cotton; C, syphon tube; D, vulcanized caoutchouc; E, compressor; F, terminal glass tube.



Salmon, del.

Fig. 3.

Bacillus which developed in beef infusion in cultivation tubes after these had been heated seven times to over 200° Fah. on water-bath. Stained with aniline violet. X 1500.

SWINE PLAGUE, FOWL CHOLERA AND SOUTHERN CATTLE FEVER.

Investigations by D.E. Salmon, D.V.M. Plate IV

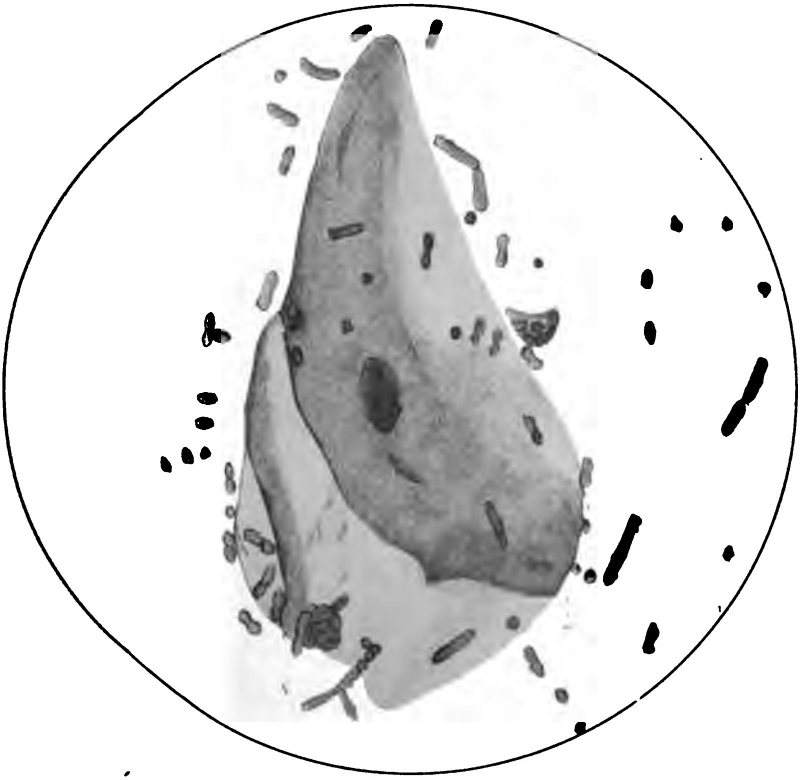


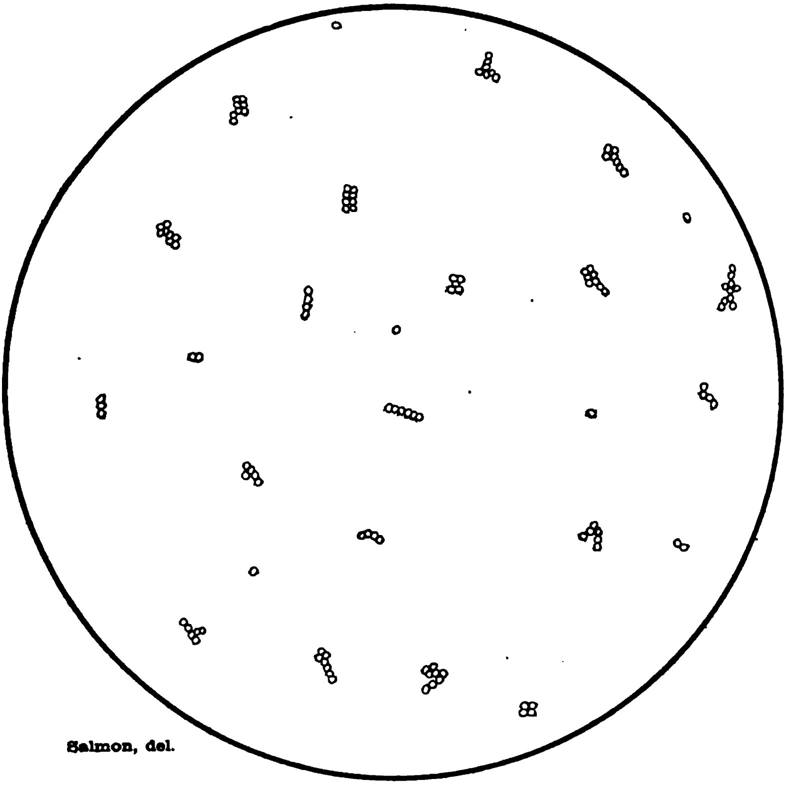
Fig. 4.

FOWL CHOLERA.

Bacteria with epithelium, from human mouth in health. From preparation made by drying, staining with aniline and mounting in Canadian balsam.

x 1500.

Salmon, del. T. Sinclair & Son, Lith.



Salmon, del.

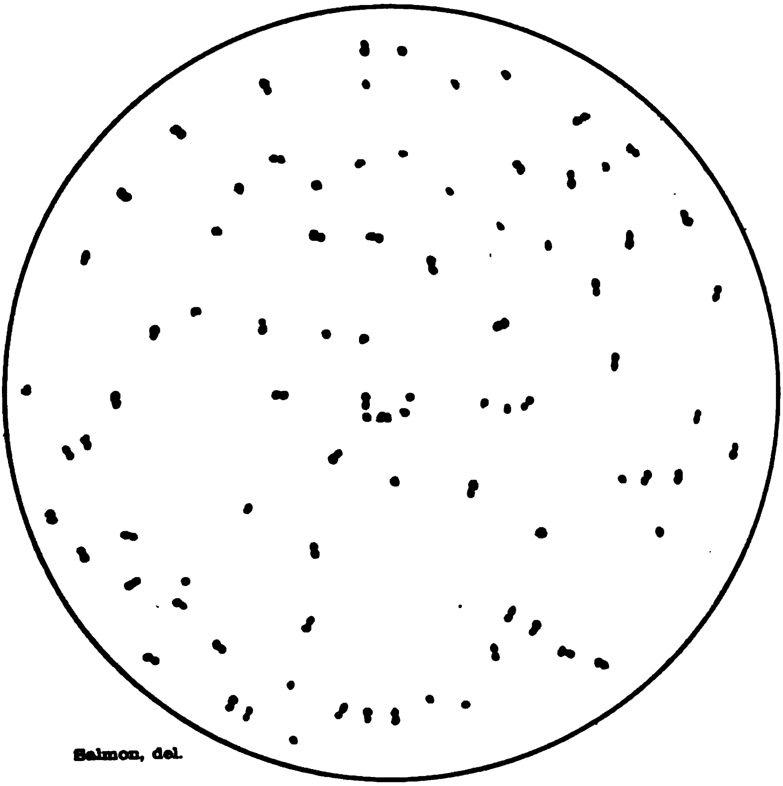
Fig. 5.

Swine Plague: Appearance of sixth cultivation used to inoculate Pig, Jan. 17th. X 1000.

FOWL CHOLERA.

Fig. 6. Size and appearance of liver in a case of the disease, May 19th 1881.

T. Sinclair & Son, Lith.



Salmon, del.

Fig. 7.

Fowl Cholera: Bacteria in pure cultivation of virus; preparation made by drying, staining with aniline violet, and mounting in Canada balsam. X 1500.

SWINE PLAGUE. FOWL CHOLERA AND SOUTHERN CATTLE FEVER.

Investigations by D.E. Salmon D.V.M.

Plate VIII

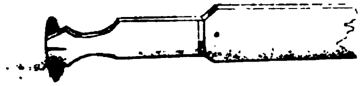


Fig. 8.

Fig. 9.

FOWL CHOLERA.

Method of inoculation and appearance of lesion after three days, the effects of the virus not yet apparent.

T. Sinclair & Son, Lith.

SWINE PLAGUE, FOWL CHOLERA AND SOUTHERN CATTLE FEVER.

Investigations by D.E. Salmon D.V.M. Plate IX

Fig. 10.

Salmon del.

Fig. 11.

FOWL CHOLERA.

Fig. 10. Local lesion after ten days when virus is inactive or fowl insusceptible.

Fig. 11. Local lesion produced after ten days by active virus diluted 1 to 10,000.

T. Sinclair & Son, Lith.

SWINE PLAGUE, FOWL CHOLERA AND SOUTHERN CATTLE FEVER.

Investigations by D. E. Salmon D.V.M. Plate X.

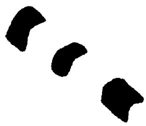


Fig. 12.

Fig. 13.

Fig. 14.

Salmon del.

FOWL CHOLERA.

Sequestrum formed as a consequence of the hypodermic injection of the extract of cultivation liquid.

Fig. 12. As seen before removal and partly covered with epidermis.

Fig. 13. After removal.

Fig. 14. Cross section of same.

T Sinclair & Son, Lith

SWINE PLAGUE, FOWL CHOLERA AND SOUTHERN CATTLE FEVER.

Investigations by D. E. Salmon, D. V. M. **PLATE XI.**

Fig.18.

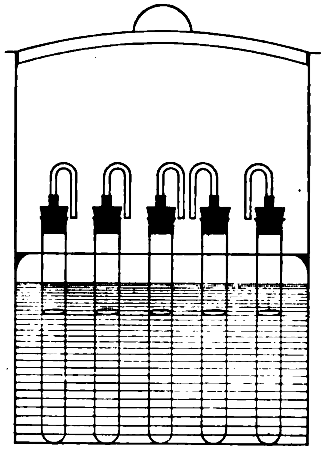


Fig.16.

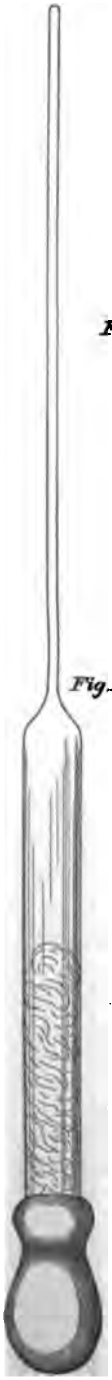


Fig.15.

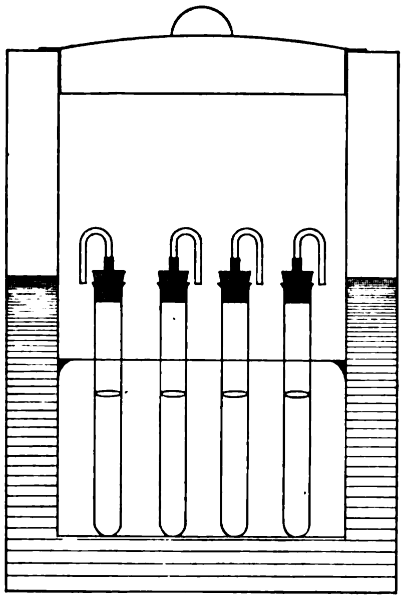
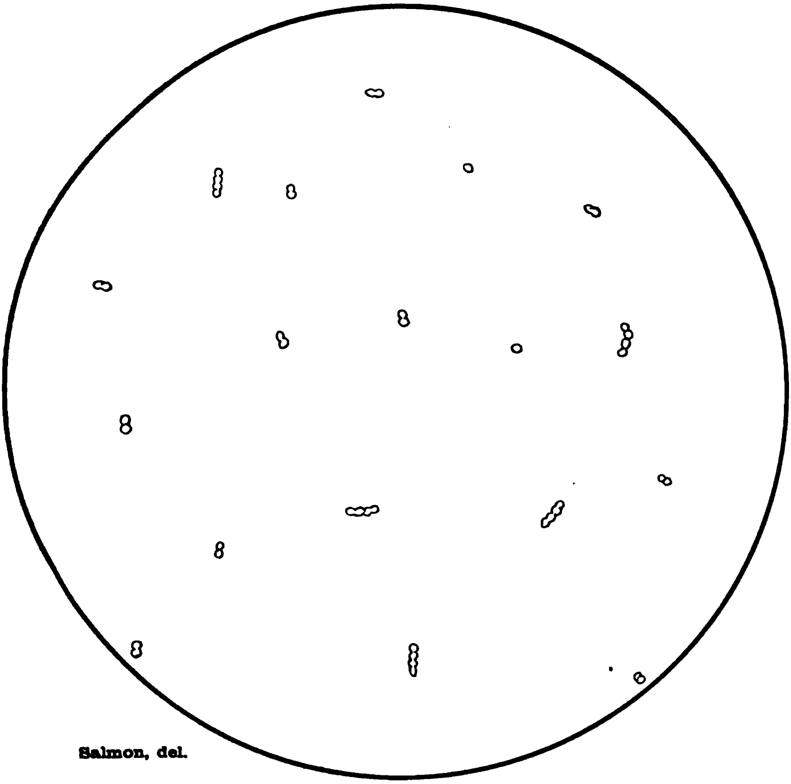


Fig.17.

Fig. 15.—Capillary pipette for removing liquid from cultivation apparatus.

Figs. 16 and 17.—Different forms of sterilizing apparatus.

Fig. 18.—Capillary tube for inoculating cultivations.



Salmon, del.

Fig. 19.

Fowl Cholera: Bacteria as seen in a fresh cultivation of virus. Those appearing like single globules are really dumb-bell forms in a vertical position. When actively vegetating two dumb-bell forms are frequently united, and it is then difficult to distinguish them from short bacilli or Bacterium termo if these are motionless. X 1000.

VIRULENCE OF THE EXCREMENT.

If the foregoing view is correct, it follows, as an almost necessary conclusion, that the disease germs are scattered by means of the excrement of sick birds. This conclusion was adopted in my last report, although the only experiment which I had made up to that time was negative in results—the inoculated fowl not contracting the disease. This only illustrates the uncertainty of experiments in which but a single bird or animal is used. Of course it would not do to allow such an important point in our theory of the disease to go without positive experimental evidence, and therefore the following experiment was made:

Experiment No. 1.—Two chickens were inoculated February 2 by four lancet punctures, each with fresh excrement of a fowl that died this morning, and which had been affected in a chronic form.

February 8.—Urates tinted.

February 9.—Urates yellow.

February 17.—The urates have continued yellow; to-day there is plain diarrhea.

February 27.—Both have had severe diarrhea, with loss of appetite. One is better.

March 11.—One dead. The second has recovered.

We have here positive evidence that the germs of the disease are contained in the excrements of sick fowls, and, as we have before shown, that taking these germs into the digestive organs was sufficient to produce the disease, our theory of the manner in which infection occurs may be regarded as complete.

THE EFFICIENCY OF DILUTED SULPHURIC ACID AS A DISINFECTANT.

The solution of commercial sulphuric acid of the strength of 1 part to 200 of water, which I have heretofore recommended as a cheap and most efficient disinfectant in this disease, has been in continual use during these experiments. I have shown in my former report how dangerous it is to place susceptible fowls in coops that have been occupied with those sick with cholera when no disinfection is practiced. During these experiments it has been necessary to use the same coop over and over again, and frequently it was impossible to place them upon fresh ground, and in some cases even the accumulations of excrement were not removed; at all times reliance was placed upon this disinfectant, and the watering troughs, coops, and ground thoroughly saturated with it. In no single instance, out of more than a hundred, have the most susceptible fowls contracted the disease from such disinfected coops or grounds. The value of this agent is then fully confirmed by a large number of cases. It deserves even more credit for efficiency than I have before given it, since considerable accumulations of virulent manure have been rendered perfectly harmless after a thorough saturation with it. As a disinfectant, therefore, it cannot be too highly recommended, and it should be largely used by all who suffer from the ravages of this plague.

VIRUS NOT INDEFINITELY PRESERVED IN EARTH.

With certain diseases, as for example charbon, the pathogenic germs retain their potency for years, and animals pasturing over the grounds where the dead ones were buried may contract the affection. Does anything analogous occur when fowls which have died of cholera have been buried, and may the virus be thus preserved to cause outbreaks in succeeding years? As an answer to this important question the following experiment is offered:

Experiment No. 2.—Part of the body of a fowl that died of cholera in July, 1880, and had since been buried in the open ground fifteen inches deep, was exhumed January 12th and with a considerable amount of the surrounding earth was placed in a coop with two healthy fowls.

February 2.—These birds are still in good health.

They were then inoculated with active virus to test their susceptibility to the disease, and both sickened in due time.

It seems pretty certain, therefore, that the germs are not preserved in the earth for a period of six months.

THE GERMS MAY RETAIN THEIR VIRULENCE A CONSIDERABLE TIME UNDER CERTAIN CONDITIONS.

It is probable, and indeed one might say certain, that the time during which the germs of a disease retain their activity depends very much upon the condition in which they are kept; whether they are exposed to extremes of dryness and moisture, to heat or cold. Putrefaction seems to be one of the principal causes of destruction of the virus under natural conditions. Thus a virulent liquid which is contaminated with atmospheric bacteria loses its activity in a few days, while the same liquid preserved in the cultivation tubes which are ventilated with pure air retain their virulence for months. A relatively small number of atmospheric bacteria do not produce this effect, for the cultivations may not be exactly pure and yet be virulent for two or three months.

A susceptible bird was inoculated with blood and fed parts of the muscles of a cholera victim, which had been buried about fifty hours, in warm weather, and the result was only a very mild attack of the disease, characterized by diarrhea for two or three days, with deep yellow urates, but without loss of appetite or somnolence. Whether this attenuation of the virulence is one of the stages of the destruction of the virus in all cases of putrefaction I have not yet determined, but it is not unlikely, judging from what is now known of the subject.

December 13 five fowls were fed with the livers and muscles of birds that had died November 13 and December 9. The weather had been intensely cold and the bodies had been frozen, so that putrefaction had not set in. Up to December 19 there was no appearance of disease, and all five were placed in a coop, in which the last sick bird had died November 13. Two days later (December 21) yellow urats were observed, so that one or more must have contracted the disease from eating the frozen organs of the dead birds. December 24 two were plainly sick, and the following day one was dead. This experiment was not made at the time to throw light on this subject, but simply to keep up the supply of virus, and hence the details are not what would be demanded from a scientific experiment; but, neverthless, it gives conclusive evidence that the virus is capable of resisting four days of freezing and still produce fatal results when introduced into the body.

Experiment No. 3.—Three chickens were inoculated by lancet punctures January 10, 1881, from a cultivation flask that had been prepared September 9, 1880. January 18 the urates were slightly tinted, but there were no other indications of disease. The next day, as they appeared perfectly well, two received a hypodermic injection of 1¼ cubic centimeters each, and the third of 2 cubic centimeters of the same liquid to determine if it still retained any virulence. January 20 the urates were plainly tinted and the birds dull, but they were better the next day and did not contract the disease.

The temporary coloration of the urates, which frequently occurs after inoculation with devitalized virus, seems to be due to some chemical body produced during the multiplication of the disease germs. That they did not have a mild attack of the disease seems certain, since when they were shortly afterwards inoculated with active virus two died and the third was very sick.

In this case the virulence was entirely lost within four months. The liquid, however, was not a pure cultivation but contained some septic bacteria.

Experiment No. 4.—January 10 three fowls were inoculated with blood preserved in a vacuum tube and hermetically sealed since October 21. These did not contract the disease, though their susceptibility was afterwards proved by inoculation with active virus. In this case the activity was lost in less than three months.

Experiment No. 5.—Three birds were inoculated January 10 with blood preserved in a vacuum tube hermetically sealed since October 8. These received all that could be inserted in four lancet punctures. All remained well.

Experiments Nos. 4 and 5, therefore, indicate that the liquid blood, even when preserved from the influence of the air, is not a favorable medium for the long preservation of the virus.

Experiment No. 6.—A single bird was inoculated September 8 with cultivation liquid from tube prepared June 27. This inoculation was followed by considerable swelling, redness, and whitish deposit at the point where the virus was inserted. It disappeared in the course of three weeks, the bird remaining continually in good health. As will be seen further on this swelling and deposit indicates the attenuation but not the destruction of the virus.

Experiment No. 7.—September 6 a single bird was inoculated with cultivation liquid sealed in vacuum tube since June 27. The swelling and deposit which resulted were similar to that in the preceding experiment, though more intense. No sickness resulted.

Experiment No. 8.—Four birds were inoculated October 4 with cultivated virus preserved in a vacuum tube since June 27. October 18 all are sick with somnolence, diarrhea, deep yellow urates, total loss of appetite, and great thirst. October 20 two were dead. The remaining two recovered.

In experiments Nos. 6 and 7, then, the virus retained considerable activity after more than two months' preservation, and in experiment No. 8 the activity was very great after more than three months (100 days).

Experiment No. 9.—Three fowls were inoculated January 10 with blood that had been dried October 25, but had been continually exposed to the air. January 17 one was found dead, though there had been no diarrhea or coloration of the urates. The lesions were not very pronounced but resembled those of fowl cholera. To decide as to the nature of the disease the flesh was fed to the remaining two birds of this lot. January 21 one or both have diarrhea with slightly tinted urates and loss of appetite. January 23 one dead and the other sick. A small quantity of blood from the dead bird, obtained with suitable precautions, was placed in a cultivation apparatus. January 24 the cultivation shows turbidity after thirty hours and contains the motionless dumb-bell micrococci of fowl cholera.

In this instance the virus must have retained its activity unimpaired for two and one-half months, though it is to be noticed that but one of the three sickened from the inoculation. It seems probable, therefore, that the greater part of the blood was inert, and that in some particle the organism had found the conditions of existence more favorable than in the others.

THE SIXTH SUCCESSIVE CULTIVATION OF VIRUS IN TUBES RETAINS ITS ACTIVITY UNIMPAIRED.

To show that the germs of contagious diseases are capable of growth and multiplication outside of the animal body many attempts have been made to cultivate them in harmless liquids. Some of these attempts, and notably those of M. Pasteur, have been very successful, but many others have been questionable in the extreme. When the final cultivations retain the full activity of the original virus there is, of course, no reason to doubt the success of the experiment; but when the last cultivation produces but the slightest symptoms of disease, or is altogether harmless, there is much reason for honest doubt. Pasteur has lately expressed a doubt of the modification of the *Bacillus anthracis* by continued cultivation, as is maintained by Greenfield and Buchner, and rather believes that the substitution of a very common bacterium, the *Bacillus subtilis*, has occurred instead.

It has appeared to me impossible to obtain pure cultivations according to the methods usually employed. The organisms which are most troublesome are the various forms of *bacilli*, the germs of which abound everywhere and thrive in the most different liquids. Some of these are identical in appearance with the *Bacillus anthracis*, while others are much finer and cannot be distinguished from the *bacillus* described by Klein and found in his cultivations of swine-plague virus.

In the cultivations of the micrococci of swine plague and fowl cholera it is much easier to determine the purity of cultivations by direct microscopic examination, since these organisms are so different from those which usually contaminate cultivation liquids. The *Bacterium termo* and the septic bacteria generally met with are oval or rod-shaped, and are active in their movements, while the micrococci are spherical, even when united in couples or chains, and are always motionless. The microscope can, therefore, be relied upon to determine the purity of the cultivations of these two pathogenic organisms with considerable security. In the cultivations of swine-plague virus, already referred to, and which were carried through six successive cultivations, no other organism was ever seen, though many examinations were made. This experience gave me confidence in my apparatus producing pure cultivations when properly manipulated; and though the inoculation with the last cultivation did not produce fatal results, the microscope demonstrated that no substitution of organisms had occurred, and the results of inoculation with the first and sixth cultivations showed no appreciable difference. Indeed, it is to be doubted if the animal from which this virus was taken had more than a mild form of the disease. It was with no ordinary interest, therefore, that I attempted to duplicate cultivations of the micrococcus of swine plague with similar cultivations of the organism of fowl cholera.

In May, 1881, I made a cultivation which, as near as I could determine, was free from atmospheric bacteria, and proved to be very active. Having a number of sets of apparatus containing sterilized infusion, the cultivations were carried to the sixth, transferring not more than one-fourth of a drop from each cultivation to the sterilized infusion, and thus making a dilution of 1 to 2,000 each time. Each cultivation was left in the incubator from twenty to twenty-four hours, or until the infusion became opalescent, before the succeeding one was inoculated. The result of inoculation with the last cultivation may be seen below:

Experiment No. 10.—A susceptible Plymouth Rock cock was inoculated June 2 by lancet puncture with the liquid obtained in the sixth cultivation.

June 6.—Has diarrhea, with yellow urates.

June 9.—The attack was very severe, and the bird continued to grow worse until to-day, when he died.

In this case there can be no doubt either that the virus was actually cultivated, or of its retaining its activity unimpaired, and it would appear that the cultivations might be extended indefinitely and still retain their activity if they were made under proper conditions.

PATHOGENIC ACTION OF THE BACTERIA.

Thus far it has been assumed by the writer that the essential cause of fowl cholera is a bacterium or schizophyte, but as this is still contested in some quarters, and as it is one of the most important points in our theory of the disease, it is imperative that the experimental evidence bearing on the question should be presented.

The bacteria always present.—If we depend upon demonstrating the presence of the bacteria in this disease by the direct microscopic examination of the liquids or organs of the dead fowl, we may meet with many cases that are not satisfactory. But if we place a fraction of the drop of the blood, obtained with suitable precautions, into the cultivation apparatus already described, and which contains neutral, sterilized infusion of the muscles of fowls, there will invariably be produced, in the course of twenty-four hours, at 100°F., an abundant development of the micrococcus shown in the figures accompanying this report. The presence of this organism was demonstrated by Pasteur, in France; and has been confirmed by me a great number of times within the past year. When this multiplication of the organism is seen to have occurred in the cultivation liquid, it may be confidently predicted that inoculation with much less than a drop of the liquid will produce the disease; and when the liquid remains sterile, or a *bacillus* alone develops, it is equally safe to predict that the inoculation will remain without result.

The virus retains its activity through an indefinite number of cultivations of the micrococcus.—As I have already shown, we may obtain a pure cultivation of a certain form of bacteria in an apparatus which contains from four to eight drachms of cultivation liquid. For the first cultivation not more than one-fourth of a drop of blood is taken, and this is consequently diluted two thousand fold. In the second cultivation an equally small quantity of the first is used for inoculation, and this is, therefore, again diluted two thousand fold, and so on to the sixth, as I have gone. At this time our original particle of blood must have been diluted with a quintillion times its bulk of a harmless liquid, a dilution which would destroy the most potent virus if it had not been reproduced during the process. But what has multiplied itself in our cultivations? With the naked eye we can see that the addition of the particle of virus has caused a remarkable change in the appearance of our infusion. From being transparent and limpid as the purest water, it is now opalescent, or even turbid. Under the highest powers of the microscope we see exceedingly minute globular bodies frequently or generally united by twos—bodies which from their form and size we class with the bacteria—and besides these there is absolutely nothing. Now bacteria are the organisms which cause putrefaction, and putrefaction destroys this as it does most other kinds of virus. Is our last cultivation then as virulent as the first? We inoculate with a drop, a thousandth or even a twenty-thousandth of a drop, and produce the disease. What is our conclusion? There is scarcely a reason for difference of opinion. The last cultivation is as virulent as the first; the growth of the bacteria has not interfered with the potency, as would have happened if they belonged to the septic varieties; they are the only living thing revealed by the microscope, and they are, therefore, in all probability the active principle of the virus.

The filtered liquid does not produce cholera.—Pasteur has filtered the virulent liquids through plaster filters and thus obtained from his cultivation fluids a perfectly limpid and transparent liquid free from bacteria. If the active agent were a formless ferment or other soluble chemical body we should expect that it would pass through the filter, and that the filtrate would still produce the disease when used for inoculation. This filtrate has been found unable to produce fowl cholera, however, even when injected to the amount of ten cubic centimeters.

But it has been objected that the plaster of which his filters are made is itself a chemical body, and that its contact with the virulent liquid induces a chemical change sufficient to destroy its powers. To this he replies that plaster may be mixed with the virulent liquids with impunity without interfering in the least with their activity.

The clear liquid from which the bacteria are deposited by gravitation is harmless.—Another objection to the filtering experiments has been that there are some substances which cannot be forced through certain kinds of filters, and this may be true of the body which constitutes the essential part of this virus. To meet this objection Pasteur placed his cultivations for a number of days where the temperature was without any variation, and the bacteria gravitated to the bottom of the apparatus, leaving a clear liquid above them. If, now, the virus is a soluble body it would be equally diffused throughout the liquid, and inoculations with the clear fluid taken from above the bacteria should produce the disease. This was not the case, however; the clear liquid was harmless, while the bacteria at the bottom still retained their virulence.

The virus is destroyed at 132°F. *even in hermetically sealed tubes.*—The evidence already presented must seem, to the unbiased mind, sufficient to demonstrate the identity of the bacteria with the active principle of fowl-cholera virus; but still the question was contested by some and the foundation of the theory declared insufficient. It seemed possible that the virus might be a very volatile chemical body, which escaped from the upper layers of liquid in Pasteur's experiment, and was still retained beneath with the bacteria. To determine this point I sealed virulent liquids in glass tubes and subjected them to temperatures of 132°F. and higher for a period of fifteen minutes. The activity of the virus was thus invariably destroyed; though 132°F. is so low a temperature that one would scarcely expect the most delicate chemical compounds to be affected by it in so short a time if protected from the action of the atmospheric air and from volatilization in well-filled and hermetically-sealed glass tubes.

The bacteria are destroyed at exactly the same temperature as the virulence.—Bacteria are organisms which have been looked upon as capable of sustaining a very considerable degree of heat. Some still vegetate in liquids that have been boiled three, four, or five hours, and in my experiments others have actively multiplied in a liquid continually maintained at 135° to 140°F., while other observers have seen them develop at a temperature some twenty degrees higher than this. If the activity of this virus disappears at 132°F. in fifteen minutes, is not this evidence that the essential principle is something different from bacteria? Something more sensitive to variations of temperature? Or do these bacteria differ from some others, and succumb at a point which seems very favorable to them? To answer such important questions the following experiment was made:

Experiment No. 11.—Three cultivation tubes containing carefully sterilized liquid were inoculated April 1 from the same virulent cultivation. No. 1 was then immediately heated to 130° to 131°F. for fifteen minutes; No. 2 to 131° to 132°F., and No. 3 to 132° to 133°F. for the same length of time. Twenty hours later No. 1 was opalescent, while the others were still transparent. April 4 No. 2 had also become opalescent, but on examination it was found to contain only a *bacillus* that must have gained entrance from the air during manipulations necessary to inoculation. Three fowls were now inoculated with liquid from each of these tubes. April 8 the three inoculated from No. 1 were sick, with yellow urates. The following day one was dead. April 11 a second one died. The third improved, and by April 25 was nearly well. Tube No. 3 retained its transparency as long as preserved, and the six fowls inoculated from Nos. 2 and 3 all remained perfectly well.

This experiment I look upon as very important evidence of the pathogenic action of the bacteria. They were destroyed at exactly the degree of temperature at which the virus lost its activity, and the tubes in which they were destroyed contained a harmless liquid, while that in which they reproduced themselves contained a most potent virus, as was shown by the inoculations. The various kinds of bacteria resist temperatures from 130° to 212°F. for this length of time, as many experiments made by me demonstrate. How many chances are there, therefore, that a septic bacterium accidentally present would be destroyed at some other degree than the exact point which rendered the virus inactive if this consisted of a chemical body or formless ferment? It is almost inconceivable that such a coincidence could occur, and hence this experiment by itself is sufficient to make the germ theory of fowl cholera extremely probable. But when we go over all the facts I have enumerated and weigh them collectively against the foundationless conjectures of those who criticise this theory—when we see all the suppositions of the soluble-ferment theorists failing in our attempts to verify them, and every acquired fact going to support the germ theory—the unbiased mind can reach but one conclusion: these bacteria are the pathogenic agents of fowl cholera; they are the essential agent of the virus, and without them in a living condition there can be no virulence.

THE BACTERIUM PROBABLY EXISTS IN BUT ONE FORM.

The only other pathogenic schizophyte which has been at all well studied, and which is admitted to be pathogenic with anything like unanimity, the *Bacillus anthracis*, is well known to exist in two forms. One of these, the actively-vegetating filament, is very susceptible to unfavorable conditions of life, and therefore easily destroyed; the other, the germ or spore, exists in a dormant condition like the dried seeds of plants, and is capable of resisting not only great extremes of temperature, but the action of moisture, dryness, putrefaction, and all the varying conditions to which it may be subjected when upon the surface of or within the soil. And it may thus be preserved for years in all its virulence.

Does the bacterium of fowl cholera exist under two corresponding forms—one in which it is easily destroyed, another in which it may resist unfavorable conditions and retain its activity for an indefinite time? If we make a cultivation of the *Bacillus anthracis* we find that it grows by division and subdivision of the filaments until the supply of nutriment begins to fail, when spores appear in the filaments, and after a time the latter are disintegrated, leaving the spores alone visible. Such a cultivation retains its virulence indefinitely. When, on the other hand, we make a cultivation of the fowl-cholera organism we find the particles after a time become appreciably less in size, but it has been impossible to detect the formation of spores, and instead of retaining its activity unimpaired it frequently, within two months, has lost so much of its vitality as to be incapable of producing more than a local lesion at the point of inoculation. Experiments already reported are sufficient to demonstrate this fact.

There still appeared to be considerable uncertainty, however, as to whether a spore condition might not exist having more resistance to unfavorable conditions than the actively-growing bacterium, and still not be so insensible to these as the spore of the *bacillus* of anthrax. The following experiment is reported as bearing on this point:

Experiment No. 12.—A cultivation apparatus containing sterilized infusion was inoculated April 5 from an old cultivation that had stood undisturbed for several weeks.

It was then immediately heated to 140°F. for fifteen minutes, and placed in an incubator at 100°. April 6 three fowls were inoculated from this cultivation, but all remained in good health.

The evidence so far accumulated from experimental inquiries indicates, therefore, that the bacterium does not form spores nor assume a condition in which it is more capable of resisting unfavorable conditions of life than in the actively-growing form, in which it is now so well known.

EFFECT OF A MIXTURE OF SALICYLIC ACID AND BORAX ON THE VIRUS.

In the preceding report is detailed an experiment which demonstrated that the addition of an equal volume of a 2 per cent. solution of salicylic acid, containing sufficient borax to cause solution to the virus, completely destroyed its activity within three hours. As it seemed desirable to ascertain how weak a solution of this acid might be depended upon, a second experiment was made January 24.

Experiment No. 13.—Three fowls were inoculated by lancet punctures with virus that had been treated four hours previously, with an equal volume of a 1 per cent. solution of salicylic acid made with the aid of borax. The proportion of acid was consequently one-half of 1 per cent. of the resulting mixture. January 31 yellow urates were observed. February 2 one was dead; February 6 a second dead and the third was very sick. By February 16 the remaining bird had entirely recovered.

While, therefore, 1 per cent. of this acid in combination with borax is sufficient to destroy the activity of the virus, ½ per cent. is clearly insufficient.

EFFECT OF BENZOIC ACID AND BORAX ON THE VIRUS.

A number of experiments were also given in the former report on fowl cholera which demonstrated that benzoic acid dissolved with the aid of borax invariably destroyed the virus when added to the extent of 1 per cent. of the resulting mixture. Perhaps a much weaker solution might be equally effectual. To decide this an experiment was made as follows:

Experiment No. 14.—Three fowls were inoculated January 24 with virus that had been treated four hours previously with an equal volume of a 1 per cent. solution of benzoic acid, the resulting mixture containing ½ per cent. of the acid. January 31 there was diarrhea with yellow urates. February 4 two were dead. The remaining one did not contract the disease.

Benzoic and salicylic acids would therefore seem to have about the same activity in destroying this virus. How much of this destructive power comes from the acids and how much from the borax I have not the data to determine, but since the borax entered into the solutions to the amount of one and one-half times as much as the acids, and since borax alone is sufficient in many cases to prevent the growth of bacteria when present to the extent of 2 per cent. of a solution, it seems probable that a part of the activity at least was due to this agent.

EFFECT OF CARBOLIC ACID ON THE VIRUS.

The exact proportion of carbolic acid necessary to destroy the virus was also left in doubt in the preceding report. A number of experiments demonstrated that it accomplished this in from five to six hours when added to the extent of 1 per cent., but it was not known how much smaller a proportion could be relied upon to produce the same effect. The following experiment leaves no more doubt on this point:

Experiment No. 15.—Three fowls were inoculated January 24 with virus that had been treated four hours before with an equal volume of a one per cent. solution of carbolic acid, the resulting mixture containing one-half per cent of the acid. February 1 there was diarrhea and yellow urates. The following day one was dead; two days later (February 4) a second was dead. The other did not contract the disease.

Carbolic acid, consequently, fails to be effectual at the same point as the solutions of benzoic and salicylic acids.

THE MEDICAL TREATMENT OF FOWL CHOLERA.

In the experiments which I have made to test the effect of those agents which have the best reputation as disinfectants in their direct action upon the disease germs, it has been demonstrated that they are not so efficacious in the destruction of such germs as has been generally believed. Thus as much as one per cent. of carbolic, salicylic, or benzoic acids must be added to the virus in order to destroy the bacteria in from three to six hours. Does this allow any hope of success in the administration of such agents to destroy the germs after they have commenced their multiplication in the liquids of the body? If we admit that 65 per cent. of the weight of a fowl consists of water, then a bird weighing five pounds must contain 3.25 pounds of this liquid, and to make this into a one per cent. solution would require more than half an ounce of the disinfectants mentioned, an amount far beyond any dose that could be tolerated. If, however, we admit, with other authorities, that it is sufficient to make the blood antiseptic, then there is clearly a much better chance of accomplishing our object; for the observations of Colin show that the blood of a fowl is not more than one-twentieth of the weight of its body, or in a five-pound bird but one-fourth of a pound. Now 1 per cent. of the weight of the blood would be in this case but twenty grains, an amount but one-twelfth of that in the former supposition, but yet clearly more than could be borne if introduced at once into the circulation.

It has been urged, however, with much reason, that every living organism has a certain power of resisting contagious germs—a *natura medicatrix* that is of itself frequently sufficient to effect a cure. If, therefore, we assist this natural power by making the fluids of the body unfavorable for the development of these germs, cannot our object be accomplished with a much smaller proportion of the disinfectant than is neccessary for the destruction of the germs outside of the body? Undoubtedly; but since we do not know the *modus operandi* of this resistance, have we any assurance that the administration of these antisepics will be of any assistance to the *natura medicatrix?* Do they not on the other hand depress the vital forces? Or, speaking more definitely, do they not lessen the activity or vitality of the living matter of the animal body, on the vigor of which we must depend for our success?

The subject is evidently an exceedingly complicated one—one on which much light cannot be shed by any amount of reasoning from the few facts now acquired; we must appeal to direct experimentation for the solution of the difficulties—it is our only resource. A number of experiments bearing upon this question have been made and are recorded below:

Experiment No. 16.—November 27, 1880, a valuable Plymouth Rock cock appeared dull and was found to be voiding urates slightly tinted with yellow. He was at once isolated and by night had a pronounced diarrhea; the excrement consisted almost entirely of urates of a deep yellow color, and were voided with great frequency. A solution was made containing 5 per cent. of benzoic acid and 7½ per cent. of borax, of which he received sufficient to contain five grains of acid.

November 28.—The diarrhea is excessive; the urates have a greenish-yellow color; comb and wattles very pale. Three five-grain doses of the acid solution are administered during the day by means of a dropping tube inserted into the œsophagus. The difficulty of breathing was so great that the opening to the larynx was continually distended and allowed the part of the liquid which regurgitated to enter the trachea, producing such an ominous gurgling as to make me despair of his life.

November 29.—The presence of the solution in the trachea does not seem to have done any harm; the bird is still very sick with intense diarrhea. The excrement assumes a deep-green color on drying. The fleshy parts about the head are pale and bloodless. He receives two doses of 7 to 8 grains each.

November 30.—Much the same; acid continued.

December 3.—Medicine discontinued; he is evidently better; excrement nearly normal.

December 4.—Appetite returns; seems rapidly improving.

December 5 to 9.—The weather having turned extremely cold, he has rapidly grown worse, not having sufficient vitality to resist the cold. The acid was resumed but was without result, and in an attempt to administer brandy, December 9, a small amount found its way to the trachea and produced death.

Experiment No. 17.—Two fowls were inoculated April 25 from a second cultivation of the virus. They were to receive 10 grains of benzoic acid and 15 grains of borax in solution three times daily, mixed with their food. Medicine commenced twenty-four hours after inoculation. It was found the first day that this dose was too large, causing dullness and partial paralysis. It was, therefore, reduced one-half and injected into the crop by means of a flexible catheter and rubber bulb, in order that each might receive exactly the same quantity.

April 28.—Large quantities of white urates are voided and the birds are dull.

April 29.—Yellow urates.

April 30.—One dead; the remaining one dull, with excessive diarrhea, discharges being composed entirely of urates without coloration.

May 1.—The second fowl dead.

The dose was evidently too large on the start, and the birds never recovered from the effects of the medicine, and if they did not die directly from the poisoning the course of the disease was not in the least changed.

Experiment No. 18.—Two fowls inoculated April 25 from the same virus as was used in the preceding experiment receive, three times daily, 10 grains salicylic acid and 15 grains of borax in solution. Medicine commenced twenty-four hours after inoculation. The first day this was given mixed with the food, and one—a large cock—managed to get the greater part both at morning and noon. At night he refused food entirely. The following day the dose was reduced one-half and given with syringe as in the preceding experiment.

April 29.—The cock died during the night from salicylic poisoning. The other passes much white urates.

April 30.—The remaining bird dead. The diarrhea had not been as marked as usual. On *post-mortem* a white, caseous deposit was found at the point of inoculation; the liver was enlarged and softened; the gall-bladder distended; there were ecchymoses on the peritoneum, and the kidneys contained yellow urates.

In the two preceding experiments it was evident that but one of the birds died before the appearance of the disease, but the large doses evidently depressed the vital forces too much to allow the medicine to exert any curative influence if such was possible.

That the birds did not die from poisoning, with the one exception, is shown by the course of the disease in two birds inoculated the same day from the same virus for comparison of results. Inoculated the 25th, there was yellow urates the 28th, diarrhea the 29th, one dead the 30th, and the other May 2d. With neither of these were the urates tinted as deeply as usual.

Experiment No. 19.—Two fowls inoculated April 25 from same virus as in above experiments. They receive daily 15 grains of borax in solution, commencing twenty-four hours after inoculation.

April 29.—Yellow urates.

April 30.—One dead; the other sick. Though there is intense diarrhea the urates are but slightly colored.

May 1.—The second one dead.

Experiment No. 20.—Two fowls were inoculated the same day and with the same virus as above. They receive two grains of sulphate of quinia, commencing twenty-four hours after inoculation, and repeated twice daily.

April 29.—Yellow urates.

April 30.—One very sick—plainly cholera—dies during the day.

May 3.—Remaining fowl continues well.

Experiment No. 21.—Two fowls, inoculated as in the preceding experiments, April 25, receive twice daily 2 grains of sulphate of quinia and 15 grains sulphate of iron. Medicine commenced twenty-four hours after inoculation.

April 29.—One dull, with loss of appetite.

April 30.—The sick fowl dead; the other has diarrhea with yellow urates.

May 3.—Remaining fowl quite sick; voids large quantities of excrement of normal consistency, but with very yellow urates.

May 6.—Second bird dies after being in profound coma for twenty-four hours.

Experiment No. 22.—A mixture containing equal parts of alum, sulphur, capsicum, and resin, known as Todd's mixture, having become quite popular in the treatment of this affection, and being generally regarded as a "sure cure," two fowls were inoculated May 13 with one drop of a third cultivation of virus in order to test it. These birds were given three times daily a ten-grain pill of the above mixture.

May 18.—Intense diarrhea, with yellow urates.

May 19.—Both found dead this morning.

Experiment No. 23.—A Plymouth Rock hen, having a rather mild attack of cholera, was put upon Todd's mixture May 12 and received three to five ten-grain pills daily.

May 16.—No improvement.

May 18.—Dead.

Experiment No. 24.—Two fowls were inoculated May 13 and given three times daily one ten-grain pill of sulphate of iron and a second pill containing sulphite of soda 10 grains, capsicum 10 grains, arsenic $\frac{1}{100}$th of a grain, carbolic acid (in carbolate of soda) $\frac{1}{2}$th of a grain.

May 15.—Sulphites doubled.

May 18.—Yellow urates.

May 19.—One dies during the day.

May 20.—Remaining fowl sick.

May 21.—Urates deep green and very abundant.

May 22.—Died during the night.

From these experiments it will be seen that the success of antiseptic treatment in fowl cholera is by no means flattering. In experiment No. 16 benzoic acid appeared to have been very useful, though one can never judge very accurately from a single bird. It was hoped that No. 17 would give more conclusive evidence, but from the dose being too large we can hardly consider the matter as finally decided. In all other cases we cannot see that the medicine produced the least effect either on the period of incubation or the course of the disease, and this when the dose was pushed to the utmost possible limit.

ATTENUATION OF THE FOWL-CHOLERA VIRUS.

Experiment No. 25.—A cultivation tube, containing a very active cultivation of the virus, was set aside June 27 and remained undisturbed until September 8, at which date a susceptible Plymouth Rock fowl was inoculated from it. This inoculation was followed by slight swelling, redness, caused by enlarged blood-vessels, and a whitish deposit at the point of inoculation. There were no general symptoms whatever, and by September 26 local lesion had entirely disappeared.

In this experiment there was evidently an attenuation of the virus in the same manner as that discovered by Pasteur; but to what is this attenuation due? Pasteur has announced, and it seems to be quite generally accepted by the scientific world, that this result is due to the action of oxygen upon the organism kept in an exhausted cultivation where it cannot reproduce itself. This theory rests upon an experiment of M. Pasteur's, in which cultivations were made in hermetically-sealed tubes but two-thirds or three-fourths filled with the cultivation liquid, the remaining third or fourth being atmospheric air; the virus on these was found to retain its complete activity at the end of ten months, while cultivations in flasks that were ventilated with filtered air became greatly attenuated in this time or entirely lost their vitality. At this point in the experiment the theory is a most plausible one, but when we learn the sequel a feeling of doubt must arise in every thinking mind. But a few months after Pasteur's announcement as above he stated before the Academy of Science that all of the virus in the hermetically-sealed tubes eventually perished. If it were the oxygen of the air that destroyed the virus and these tubes were completely deprived of this by the growing bacteria, as he assumed, how could the destruction have occurred in this case? Evidently the theory is too absolute. To throw some light upon the matter the following experiment was made:

Experiment No. 26.—Two glass tubes, three-sixteenths of an inch in diameter, were drawn to points at each end and one-half filled, while the other was entirely filled with infusion of fowl muscle. They were then sealed and the infusion sterilized by dropping the tubes into boiling water for half an hour at three different times. The end of each tube was then broken, with proper precautions, and they were inoculated with very active virus by dropping into their interior a bit of very fine glass thread that had been touched to the virus. The tubes were again sealed (this was June 27) and left unopened until September 8, being 73 days. At this date a bird was inoculated from the tube that contained no air. This inoculation was followed by considerable swelling, enlargement of the local blood-vessels, and a white deposit in the substance of the muscle. At no time was there any constitutional disturbance or coloration of the urates.

Owing to a press of other work the tube that was half full of air was not opened until October 2, when a cultivation was made from it, and October 4 four birds were inoculated from this cultivation. It may be remarked here that Pasteur has observed that the activity of the virus is not affected by such cultivation, and that an attenuated virus would have the same degree of attenuation after being grown in a fresh liquid as it had before; and, consequently, this cultivation could not affect the value of the experiment. This inoculation was followed by intense redness over a large area surrounding the point inoculated. October 9 there was diarrhea, yellow urates, and dullness, after which there was visible improvement until the 15th, when all were much worse, with loss of appetite, intense diarrhea, and yellow urates. October 20 two were dead and the remaining two better.

Here we see a marked difference in the activity of the virus in the two tubes; it was not the tube that contained no air, however, that had the greater virulence, but on the contrary the one that was half full of air and that had stood nearly a month longer than the other before the inoculations were made. It could not have been oxygen that attenuated the virus in the first tube, since the small amount contained must have been soon exhausted by the growth of the bacteria; and what could it have been but oxygen that enabled the virus of the second tube to retain its activity, since both were originally the same, having been inoculated from the same cultivation? To me this is an instructive experiment, and I learn from it that it is an unfavorable condition of life that debilitates and finally destroys this organism. A limited supply of oxygen is most favorable to the existence of this germ, and probably of most other pathogenic organisms, and when this condition is departed from either in our cultivation apparatus or in a tube from which oxygen is entirely excluded the result is the same. We must not forget, however, that continued existence in a cultivation liquid from which the nutriment has been exhausted is also an unfavorable condition, and that the organism, being no longer able to reproduce itself, must finally become enfeebled by age and in time entirely destroyed.

SUSCEPTIBILITY AND INSUSCEPTIBILITY.

One of the most remarkable facts relating to contagious diseases is that men or animals which have been affected and have recovered are insusceptible to the action of that particular virus in the future. In my former report I have shown that one attack of fowl cholera confers the same immunity as is observed in other contagious diseases, and all succeeding observations have confirmed this; the same immunity has also been observed to result from this cause in the disease as it occurs in France, by Pasteur, and may be accepted as a fact without the production of more experimental evidence.

A certain number of birds, however, are naturally insusceptible to this virus and do not contract the disease, no matter how frequently they may be inoculated; others are susceptible only to a modified extent, and when inoculated contract a mild form of the disease and recover. This insusceptibility, partial or complete, is congenital and not acquired; how or why it is possessed is still a mystery.

Pasteur has shown within the last year that birds which are inoculated with the attenuated virus and have a mild form of the disease acquire a certain insusceptibility, which may be increased to any extent by progressive inoculations with more active virus. The time required to obtain this attenuated virus is so great, however, and the uncertainty in regard to its strength so marked, that I have attempted to obtain a similar result in a different manner. It was hoped that this important question might be fully elucidated in the present report, but the attenuation of all of my active virus during my attempt to investigate the Southern cattle fever at Atlanta has so delayed this work that more experiments are needed before the method is made entirely practical, though there can no longer be a shadow of doubt in regard to the principle.

Susceptible birds inoculated with sufficiently minute quantities of virus only contract a local lesion.—For this class of experiments the virulent liquid must be in such a condition that it may be uniformly diffused through the diluting medium, and must contain a definite number of the bacteria in each drop. To attain these results a standard cultivation liquid is made by infusing 1,000 grains of fresh muscle from the breast of a fowl in ten ounces of distilled water; and when the organism has multiplied itself in this until the nutriment is exhausted the resulting liquid is termed *standard virus*. The diluting medium is a three-fourths per cent. solution of common salt.

Experiment No. 27.—A fowl was inoculated May 13 with 1 drop of a mixture made with 1 drop of virus and 50 drops of salt solution.

May 18.—Yellowish urates.

May 20.—Reddish swelling at points of inoculation; no other signs of disease.

May 22.—Urates have been white since the 18th, with every appearance of health.

May 28.—For two days the urates have been slightly colored with yellow; to-day they are more abundant, the experiment being liquid.

May 29.—Urates normal.

No other appearances of cholera were observed and the bird remained in the best of health.

Experiment No. 28.—A bird was inoculated May 13 with a single drop of a dilution of 1 to 500.

May 20.—Red swelling at point of inoculation.

May 22.—Yellow urates.

May 24.—Urates deeply colored; appetite still good; has a mild form of the disease.

May 28.—Urates still abundant and of a deep-yellow color; has had good appetite with the exception of two or three days; comb somewhat paler than usual; evidently improving.

May 30.—Has entirely recovered.

Experiment No. 29.—A fowl was inoculated May 13 with one drop of a dilution of 1 to 2,500.

May 20.—The points of inoculation are swollen and red, but there are no other signs of sickness.

May 24.—Swelling and redness, caused by the inoculation, subsiding; appetite good.

May 28.—Swelling nearly gone; no sign of constitutional disturbance has appeared.

May 30.—Points of inoculation entirely healed.

No other results followed this inoculation.

Experiment No. 30.—A fowl was inoculated May 13 with one drop of a dilution of virus, 1 to 5,000.

May 20.—Points of inoculation swollen and red, but no other signs of disease.

May 24.—At point of inoculation there is an irregular red enlargement three-fourths of an inch in diameter and projecting one-eighth to three-sixteenths of an inch. The appetite is poor, but there is no other sign of disease,

May 28.—The swelling is disappearing; appetite good.

May 30.—There is now scarcely a trace of the inoculation to be observed.

From these experiments the conclusion was reached that an inoculation of virus, diluted to the extent of 1 to 1,000, might be relied upon to produce a mild form of the disease which would result in the required insusceptibility; it was scarcely hoped, at this time, that the slight local lesion would have a similar influence. To test this conclusion the following experiment was made:

Experiment No. 31.—Four Plymouth Rock hens (selected because of their great susceptibility) were inoculated with one drop of a sixth cultivation of virus diluted 1 to 1,000, June 2, 1881.

June 8.—One very sick, inactive; diarrhea, with yellow urates; surface of body hot. All have white nodules at the point of inoculation. The sick bird removed and the coop thoroughly disinfected.

June 9.—The sick fowl dead.

June 12.—Remaining three fowls very sick.

June 13.—One dead.

June 14.—The third fowl dies.

June 15.—The fourth dead.

In spite of the considerable dilution, therefore, these birds contracted a most violent form of the disease and all died.

Experiments No. 32 *to* 37.—Twelve fowls were inoculated with dilutions of the virus used in experiment No. 25, and the bird first mentioned in No. 26. Each of the birds inoculated with the undiluted virus had developed a local lesion at the point of inoculation. The dilutions ranged from 1 to 2,500 to 1 to 15,000, and the inoculations were made before the attenuation of the virus had been discovered, and in the hopes that the former activity had been retained, and that the proper dilution for safe inoculation would be plainly indicated. Unfortunately for this object the virus had become attenuated, and not one of these twelve birds showed the least effect, either general or local, from these inoculations. The lancet punctures healed at once by first intention, as such wounds invariably do with fowls when no virus is introduced; there was no redness or swelling or other evidence of the introduction of a virus. The experiments are merely mentioned to strengthen the conclusion that dilution to this extent modifies or destroys the action of the virus.

As it is a matter of great interest to know the number of bacteria introduced into the body by inoculation with such diluted virus, I have attempted to form an approximate estimate from such data as I could obtain. In a number of cases the bacteria actually to be seen in a single field of the microscope have been counted, and the average is about twenty-five. Now this field is $\frac{1}{200}$th of an inch in diameter, or $\frac{3}{160000}$ths of a square inch in area, while the cover glass is three-fourths of an inch in diameter, or $\frac{675}{1600}$ths of a square inch in area; from which $\frac{675}{1600} \times \frac{160000}{3} = 22,500$ as the number of fields in each preparation; and this multiplied by twenty-five gives 562,500 as the number of bacteria in a preparation. One drop, however, is sufficient to fill the space beneath three cover glasses, and hence the number of bacteria in each drop must be 1,687,500, or in round numbers one million six hundred thousand. A drop of a dilution of 1 to 1,000 would, therefore, contain sixteen hundred bacteria, and a drop of the dilution of 1 to 5,000 would still contain 320, so that there can be no doubt that a considerable number were introduced in each inoculation with the diluted virus.

Since the above was written I have pressed my experiments in this direction as much as possible, in the hope of obtaining a satisfactory demonstration of the value of this method of vaccination in time to insert in this report at its final revision. I am therefore able to add the following experiments:

Experiment No. 38.—Two birds were inoculated November 7, 1881, with standard virus diluted 1 to 2,500.

November 13.—One has marked local lesion.

November 19.—Both have the local lesion, though it is disappearing in the one that contracted it first.

November 20.—The one having the most marked local lesion seems dull; yellow urates observed.

November 22.—The sick bird is dead; the local lesion had about disappeared. The second bird continued well.

Experiment No. 39.—Two birds were inoculated November 7 with virus diluted 1 to 500.

November 16.—Local lesion slight; one voids liquid urates of a deep-yellow color.

November 17.—One dead.

November 19.—The remaining bird has an extremely marked local lesion, with very prominent blood-vessels leading from it in different directions. Excrements largely urates, liquid, but white in color.

November 26.—Local lesion disappearing; bird appears well. This bird remained in good health.

Experiment No. 40.—Two birds were inoculated November 7 with virus diluted 1 to 10,000.

November 16.—Both have plain local lesion.

November 26.—Local lesion less marked; both in excellent health.

The three preceding experiments belong to one series; the birds were all from the same lot, and the virus from the same tube. To test the susceptibility of the fowls as well as to be certain of the activity of the virus used, two others were inoculated at the same time with undiluted virus. November 16 both were sick; the following day one was dead, and the second died November 21. Of the two inoculated with virus diluted 1 to 2,500 but one died; of the two inoculated with a dilution of 1 to 5,000 one also died; while the two inoculated with a dilution of 1 to 10,000 both remained in good health. Consequently, only one-third of those inoculated with diluted virus contracted the disease. Dilutions of 1 to 2,500 and 1 to 5,000 are therefore still too active for vaccination purposes, while it would seem that 1 to 10,000 might prove successful. To test this another experiment was made:

Experiment No. 41.—November 28 five fowls were inoculated with standard virus diluted 1 to 10,000.

December 3.—Three have local redness.

December 5.—All but one have plain local lesions.

December 7.—All have the local lesion.

December 10.—One sick; it is at once isolated.

December 11.—The sick fowl dead.

December 12.—Another sick; isolated; this is the one in which the lesion developed latest, and that has now disappeared.

December 13.—The bird isolated yesterday is dead; the remainder continue well.

As a consequence of the mortality in this experiment it was necessary to test the effect of virus diluted to an even greater extent.

Experiment No. 42.—Four birds were inoculated December 21 with virus diluted 1 to 20,000.

December 26.—One has local lesion.

December 31.—The one with lesion is sick; one other has a very slight lesion.

January 1.—Sick one dead.

January 2.—Another sick.

January 6.—The second one dead; the others remain well.

Experiment No. 43.—Four birds were inoculated December 21 with virus diluted 1 to 40,000.

December 29.—One has slight local lesion.

January 7.—One dead; the others remain well.

Experiment No. 44.—Four birds were inoculated December 21 with standard virus diluted 1 to 80,000.

December 28.—One has local lesion.

December 31.—Two have plain but rather slight lesions. All these birds remained well.

The greatly increased susceptibility of this lot of birds over those previously used was probably due, at least in part, to the cold and very wet weather prevailing during the time of the experiments. Two points are, however, very apparent: first, a local lesion may be produced in fowls with sufficiently diluted virus from which they will recover without constitutional disturbance; second, owing to the enormous difference in the susceptibility of fowls a first inoculation, to be safe, must be made with a dilution of 1 to 80,000, or weaker. A few more experiments would probably develop a perfectly safe method of producing the local lesion.

SUSCEPTIBLE BIRDS WHICH CONTRACT THE LOCAL LESION FROM DILUTED VIRUS BECOME INSUSCEPTIBLE.

Experiment No. 45.—The bird which in experiment No. 27 was inoculated with virus diluted 1 to 50 was inoculated June 2 with pure virus. He remained in perfect health, without the least appearance of a local lesion at the point of inoculation.

Experiment No. 46.—The fowl which in experiment No. 28 was inoculated with virus diluted 1 to 50 was again inoculated June 2, this time with pure virus. There was neither local lesion nor sign of general disturbance.

Experiment No. 47.—The fowl which in experiment No. 29 was inoculated with virus diluted 1 to 2,500, and had a well-marked local lesion, was inoculated June 2 with an equally potent virus diluted 1 to 500. This was followed by no local lesion or sign of ill health.

Experiment No. 48.—The bird which in experiment No. 30 was inoculated with virus diluted 1 to 5,000, and which had a marked local lesion, was inoculated June 2 with an equally active virus diluted 1 to 500. This remained in perfect health, the lancet puncture healing as though no virus had been introduced.

Experiment No. 49.—The four birds which survived in experiments 38, 39, and 40, one of which was inoculated with a dilution of 1 to 2,500, another with a dilution of 1 to 5,000, and the remaining two with a dilution of 1 to 10,000, and all of which had plain local lesion, were inoculated December 6 with standard virus diluted 1 to 500. This produced no effect, and by December 12 all traces of the wound made by the inoculating lancet had disappeared. These birds were, consequently, entirely insusceptible to virus of this strength, though it was five times stronger than the strongest used in the former experiment and twenty times stronger than the weakest.

Experiment No. 50.—The four birds of the preceding experiment were inoculated December 13 with pure standard virus.

December 19.—The excrement of one bird plainly indicates an attack of cholera: that of a second is slightly tinged with yellow.

December 22.—The sick bird had an exceedingly mild attack, only indicated by the yellow and liquid urates. All are now well.

No other symptoms of disease were observed with these birds.

From this experiment I concluded that an inoculation with diluted virus, which was followed by a well-marked local lesion, was sufficient to protect against an ordinary dose of standard virus.

Experiment No. 51.—Seven birds, which had been inoculated with virus diluted 1 to 10,000, and all of which had contracted the local lesion, and at least two of which had mild, general symptoms as well, were inoculated December 21 with the most active virus.

In one or two cases liquid and yellow urates were observed as a consequence of this inoculation, but there was no loss of appetite or dullness, and the birds have all remained in excellent health.

This is the extent to which I have been able to carry my researches in regard to inoculations with diluted virus and the immunity thereby conferred. It seems evident that a little more investigation will develop a safe method of protective inoculation, or vaccination, with such dilutions, by which all the effects of the attenuated virus may be obtained with greater certainty and without waiting five to eight months for the attenuation to be produced. The value of such a method to the investigator cannot be overestimated, and to the general public it offers a most effective means of combating the disease, since the immunity which it grants is at once very complete and may be carried to any desired extent.

INSUSCEPTIBLE BIRDS INOCULATED WITH SUFFICIENTLY LARGE QUANTITIES OF VIRUS SUCCUMB TO THE DISEASE.

We are brought by the preceding experiments to inquire into the nature of susceptibility and insusceptibility, one of the most profound mysteries in the whole realm of pathology. We may not be able to solve so difficult a question at the first trial, but its importance has led me to endeavor to throw some light upon it, in the hope that little by little we may be able to thread the intricacies surrounding it. The experiments made up to this time would seem to indicate that susceptibility is by no means an absolute term but simply a relative one. A fowl may be susceptible when one drop of pure virus is placed where it can readily be absorbed into its system, but it may not be susceptible when inoculated with but one twenty-five hundredths of this amount. Can we now extend this conclusion and say that a fowl which is insusceptible when inoculated with one drop will contract the malady if inoculated with ten, twenty, or fifty drops? Evidently this point must be decided by experimentation, and for this purpose the following experiments were made:

Experiment No 52.—Two fowls were inoculated May 25 with ¼ cubic centimeter of a fourth cultivation of the virus. These fowls had been several times inoculated with two and three drops at a time, and consequently this was no great increase, being not over six or eight drops.

Neither of these contracted the disease.

Experiment No. 53.—Two fowls insusceptible to small quantities of virus received May 25 ½ cubic centimeters, injected beneath the skin with a hypodermic syringe. One of these died of cholera June 5, the other remained well.

Experiment No. 54.—Two insusceptible fowls were inoculated May 25 with 1 cubic centimeter of virus injected hypodermically.

Neither contracted the disease.

Experiment No. 55.—Two insusceptible fowls were inoculated May 25 with hypodermic injection of 2 cubic centimeters of virus.

May 31.—One very sick with the characteristic symptoms of cholera.

June 1.—One dead and the other sick.

June 3.—Second dead.

Experiment No. 56.—Two insusceptible fowls, which had been repeatedly inoculated with two to four drops of virus and had never shown the least symptom of cholera, received May 25 a hypodermic injection of 5 cubic centimeters of pure virus.

May 30.—Both have loss of appetite and one or both have diarrhea with yellow urates.

May 31.—One dead.

The second soon recovered its appetite without exhibiting any other symptom of the disease.

These experiments demonstrate conclusively that birds which can very well resist inoculations with two or three drops of virus may succumb if the quantity is increased to from three to twenty times this amount. They also demonstrate that some birds may resist enormous quantities of virus, as in No. 56, where one was scarcely sickened by 5 cubic centimeters, an amount one hundred thousand times as much as sufficed to destroy the four fowls in experiment No. 31, or one million times as much as destroyed the two fowls in No. 41.

It seems to me perfectly reasonable to conclude, from the experiments so far detailed, that every fowl has a certain power of resisting the inroads of the organism which constitutes the essential cause of fowl cholera; and that the relative power of resistance may be accurately measured by the quantity of one of these standard cultivations of virus which must be placed within its tissues, to either produce the local lesion or an attack of the disease. In other words, a certain number of the bacteria, of the most virulent cultivations, may be introduced within the cellular tissue of the most susceptible fowl and still not be able to reproduce themselves sufficiently to cause an attack of the disease.

THEORIES OF INSUSCEPTIBILITY.

Why is it, we may ask, that under certain conditions the most active and most virulent bacteria are unable to multiply in the body of a fowl? How can it be that a bird is able, under any conditions, to resist the effects of the active virus? In what does insusceptibility consist, and how is it produced? What momentous questions are these; and, if decided, what new lines of investigations might they not indicate?

In the treatment of these diseases (the contagious fevers) we see our efforts are useless, even when nature unaided is often successful. Why is this? It can only be because we do not understand the nature of the resistance which the animal body offers to such enemies, and instead of assisting we often prevent the full exercise of these inherent powers. In our efforts to produce insusceptibility in individuals we have been obliged to grope our way in the dark, and where we have succeeded once we have, until very lately, failed many times; while in our endeavor to produce insusceptible breeds we are yet entirely without success. Indeed our efforts to combat a certain number of contagious diseases seem to depend to a very great extent upon a more or less complete solution of this question of susceptibility and insusceptibility, and if this can once be solved we certainly shall have gained an immense advantage.

M. Pasteur was one of the first to attack this question, and in his quality of a chemist has undoubtedly viewed it from the laboratory standpoint, and has given it a material aspect which may not be entirely satisfactory to those who look upon the powers of the animal organism in this respect as being rather of a vital than a chemical nature. But his views being based upon facts, and being those of one of the profoundest investigators the world has ever known, deserve much more than ordinary attention.

The animal body, says Pasteur, may be compared to a flask of cultivation liquid. If we add to this flask an infinitesimal quantity of virulent blood the organism multiplies with extraordinary rapidity for three or four days, at the end of which time its growth entirely ceases. If now the *microbe* is entirely removed by the filtration and fresh virus added to the transparent filtrate there is no further multiplication; the microphyte is entirely unable to reproduce itself in this liquid. If instead of filtering the liquid on the fourth day this had been done as early as the second, then there would have been a feeble growth of the fresh virus in the filtered infusion. So if we inoculate a fowl with active virus the *microbe* multiplies in the bird's body a certain length of time, and if the disorders which it produces have not caused death by that time the reproduction ceases, the bird recovers, and is henceforth insusceptible. If vaccinated with a very weak virus the growth is incomplete, and afterwards the bird's body is in the condition of the infusion filtered the second day after inoculation, and if vaccinated later with a stronger virus there is again a certain amount of reproduction.

Now this inability to multiply may be due, according to this scientist, to one of two possible causes. The *microbe* in its growth may have exhausted the available supply of pabulum suited to its use, or it may have added some chemical compound which rendered the liquid unfavorable to its multiplication. If a cultivation is prepared, and after the growth of the *microbe* is completed this is evaporated *in vacuo* at a low temperature and then restored to its former volume by the addition of fresh infusion, then, if the cultivation contained a chemical substance which prevented further development, the new liquid would contain it as well and would not be suitable for the multiplication of the *microbe*. But this is not the case; there is a fresh and vigorous growth which proves that the reproduction ceases in such liquids because some essential principle has been exhausted.

M. Chauveau, who is also one of the foremost investigators of the times, does not accept this theory, and evidently looks at the question rather from the standpoint of the physiologist and practitioner. In his investigations of charbon he found that the insusceptible Algerian sheep would contract the disease if inoculated with large quantities of virus. If the bodies of these sheep had been exhausted of the greater part of the elements necessary for the proliferation of the bacteria by one or several anterior cultivations, why would they be more favorable to the reproduction of these organisms when a large number were introduced than when only a few? If the sterility of the medium is the obstacle to the proliferation, ought not this to manifest itself all the more plainly with the increased number of germs placed there to multiply? If this is certainly true of a cultivation tube, ought it not also to be true with the animal body? He therefore formulated a theoretic interpretation of the fact observed by saying that "the comparative bacteridian inoculations with little or much virus acted with the Algerian sheep as if the infection agents encountered in the animal organism matters or agents, over which they triumphed more easily when they were in large numbers." According to M. Chauveau, then, the bacteria in their growth add a chemical substance to the liquids of the body which renders these in the future unfavorable to the growth of the particular species of bacteria which produced it.

When the unbiased student comes to consider these views, however, they both seem improbable. The animal body is very different from a cultivation flask to which nothing gains entrance or from which nothing is eliminated. Pasteur himself has shown that when fresh infusion is added to the exhausted cultivation liquid a new growth of bacteria at once occurs; what is to hinder this continuous growth in the body of a fowl which is continually absorbing elements that we know to be sufficient for the growth of our organism? Again, the experiments which I have just recorded show that a bird may be rendered insusceptible by a local development of a *microbe* in an extremely small area, and would it not be impossible for any substance to be exhausted from the body by such a circumscribed proliferation? Then we know from the other experiments I have related that the same objection may be brought in regard to the different effects of different doses of the virus with fowl cholera that Chauveau has suggested in regard to charbon; an apparently insusceptible fowl is inoculated with a large quantity of virus, the *microbe* multiplies with its usual facility and causes the death of its victim. On the other hand, how unlikely that the animal body should retain for any length of time such a foreign principle—a poison—as Chauveau supposes? This could only be accounted for on the supposition that it is a body that cannot pass through animal membranes; but we know this supposition is not correct because the fetus is rendered insusceptible by inoculation of the mother, though the *bacilli* do not gain entrance to its circulation, as has been shown by Chauveau.

While reflecting upon this subject it occurred to the writer that the phenomena observed with the ordinary bacteria of putrefaction might serve, to a certain extent, to solve these contradictory opinions. If, for example, we take the bacteria which proliferate with the greatest rapidity in the blood or other liquids of a dead animal and introduce them by inoculation into the body of a living one of the same species, we find, in the vast majority of cases, that these are unable to reproduce themselves. Evidently this is not because the living animal contains any substance that the dead one did not, or because it is wanting in any element contained in the latter, for if dead it would in its turn become the prey of these organisms and putrefy. Will the insusceptible fowl, then, furnish an infusion which is sterile or fertile, as tested by the growth of the infectious agent of this disease? The following experiments furnish an answer to this question:

Experiment No. 57.—A fowl, which had resisted repeated inoculations with the most potent virus, was killed and an infusion of the muscles made in distilled water. A number of cultivation tubes were charged with this infusion and sterilized. One of these was then inoculated with a fraction of a drop of a second cultivation which appeared to contain no other organism. In a few hours, much sooner than usual, I thought, it had become milky from multiplication of the bacteria. The next day a second tube was inoculated from the first, which in turn soon showed the development of the bacteria. Here were two successive cultivations in the infusion of the insusceptible fowl's muscles; the proliferation was even more vigorous than usual. Was it the organism of fowl cholera or indeed a septic bacterium that changed the appearance of our liquid? An inoculation experiment can alone give a satisfactory decision.

Experiment No. 58.—February 17, 1881, three fowls were inoculated, by lancet puncture, with the second cultivation in the infusion from the insusceptible bird.
February 22.—One is sick, somnolent, with greenish-yellow urates.
February 23.—One dead.
February 25.—Another very sick.
February 27.—Second one dead.
The third had a mild attack and recovered.

Since this experiment I have invariably made my cultivation liquids from the muscles of those birds which proved insusceptible and I have never failed in my cultivations. It is demonstrated, therefore, that the bacteria neither abstract a principle from the fowl's body which is necessary to their existence, nor do they add one which is unfavorable to their growth.

Must we admit, then, that this subject is still to remain a complete mystery, inapproachable by our methods of research, a stumbling-block to the science of the present time? I think not; already light is dawning upon some of the points that together make up this great problem, and after long hesitation I offer a provisional theory which shall be the basis of my work until additional facts are developed.

Let us inquire, first, as to the different conditions which exist between the insusceptible fowl and the infusion made from its muscles with distilled water. The latter evidently contains all the soluble ingredients of the former not coagulable by heat, and no more. If the fowl lacked an element necessary to the bacteria this must also be lacking in the infusion, and as it has been shown that these bacteria do not produce a poison that interferes with their development, we may conclude that the fowl did not contain such a principle. The temperature we know to be favorable in both cases. Why, then, do the bacteria multiply in the infusion and not in the body? Where is the difference of condition sufficient to account for such a fact?

Many would refer this to the vital influence of the living tissues and consider the question answered, but this term only serves as a cloak for our ignorance; it reveals nothing of the nature of that influence, and this it is of the highest importance we should understand. We may forget for the moment that we are studying fowl cholera. The principle we are endeavoring to establish is of general application and will undoubtedly hold good with all non-recurring contagious diseases.

The anatomist knows that the animal body consists of solid and liquid constituents—of dead as well as living matter. The living matter exists either in cells fixed in the solid parts of the body or free and wandering about apparently at pleasure. But between the fixed cells and outside of the blood-vessels there are relatively vast reservoirs and channels filled with a nutritive liquid which is undoubtedly favorable to the sustenance of disease germs. In this fluid, as in the blood, are to be found masses of living matter (*leucocytes*, wandering cells), it is true, but they are relatively far apart. Bacteria might exist in immense numbers and be as little incommoded by the presence of these cells as are the trout by the rocks in our mountain rivers; and it is plain that what influence is exerted favorable or unfavorable to the parasites must be by something taken from or added to the nutritive liquid. Lymph and blood plasma evidently contain the soluble constituents of the body, and if the infusion of the muscles is favorable for the growth of bacteria, these should be even more so. In the case of insusceptible fowls, however, these liquids of the living body are either less favorable or entirely unfavorable, while the infusion remains as favorable as before. Why? I see but one condition in which there is an essential difference between the cultivation liquids and the fluids of the living, insusceptible fowl, and that is the supply of oxygen.

Is there any reason for believing that the insusceptible fowl contains less free oxygen than the susceptible one? I know of none. It is probable that the susceptible bird even has too little free oxygen in its liquids when in perfect health for the requirements of these bacteria. How otherwise can we explain the fact that two or three hundred of these microphytes may be introduced within the tissues in such birds and still not be able to multiply sufficiently to produce the disease? In these susceptible birds the conditions for the nourishment of the bacteria we know to be most favorable. But why should increasing the number of bacteria increase the supply of oxygen? It does not, but it prevents the living annual matter from using it, either partially or completely. The bacteria of fowl cholera, in common with many other varieties, produce, during their proliferation, a narcotic substance which checks the activity of, or entirely destroys, the animal bioplasm. Pasteur has proved this by injecting an extract made with cultivation liquids from which the bacteria were removed by filtration, a fact which I have abundantly confirmed, as will be seen further on.

When we use a considerable amount of virus in our inoculations we not only introduce a relatively large amount of the poisonous liquid which narcotizes the adjacent cells, prevents their using the free oxygen and allows this to accumulate until the bacteria obtain a foothold, but what is of even more significance we introduce a vastly increased number of bacteria to take advantage of this condition and overwhelm the living tissues with their poisonous products, of which they are continually manufacturing larger and larger supplies, until the whole system is brought under its influence.

Why, then, does not this process go on the same in birds which have been vaccinated, or in those which have recovered from a first attack? We still have no explanation of the resistance to the inoculations with large quantities of virus. When we study the effects of narcotics, however, we learn that by placing the body under the influence of them for a considerable time a marked toleration of their effects is acquired; thus the confirmed morphia taker sometimes requires one hundred or, as I have been reliably informed, even two hundred times the dose to produce a given effect that is necessary with those not accustomed to its use. So when a bird recovers from cholera the cells of its body have become accustomed to the effect of the narcotic in the strength which it exists in the liquids of the body; they gradually resume their former activity; the supply of available oxygen is reduced, until finally the bacteria are no longer able to multiply. When we inoculate with attenuated virus the effect is similar, only the multiplication of bacteria is generally local. The narcotic is produced at the point of inoculation, is absorbed and carried by the circulating liquids to every part of the body. The leucocytes, too, undoubtedly crowd to the point inoculated as they do to every other local irritation; here they come in contact with the poison in its full strength, and afterwards, when they have migrated elsewhere—when they have become fixed and are a part of the tissues—this exposure, this adaptation to the influence of the narcotic is probably an important feature in the insusceptibility.

For this reason a first vaccination is not always successful in producing complete immunity; more time must be allowed during which the poison is poured into the system, and during which the leucocytes are visiting the local lesion. Even after the organism as a whole is insusceptible to the influence of the bacteria and their products an inoculation may be followed, according to Pasteur, by one or more small local abscesses, in which the microphytes are found in abundance; in this case there were still some groups of cells unable to resist the poison, and the growth of the parasite was a local and not a general one.

The main points in this theory are, then, as follows: 1. The pathogenic bacteria are able to live in a more limited supply of oxygen than the ordinary septic ones. (In this theory we have left out of consideration the anerobic bacteria, which have been little studied and which live without any free oxygen. The diseases produced by these might not grant an immunity from subsequent attacks, and probably at best only a partial immunity. The malarial fevers, glanders, and tuberculosis may belong to this class.) 2. The animal bioplasm flourishes with a supply of oxygen still too limited for even the pathogenic bacteria. 3. It is only by a poisonous principle formed by the bacteria which narcotizes the bioplasm at the point of inoculation and allows an accumulation of oxygen that the disease germs are enabled to multiply. 4. In time the animal bioplasm becomes accustomed to this, as to other narcotics, and is thenceforth insusceptible to its action.

It is now a matter of great interest to ask how far this theory is upheld by experiments with other bacterial diseases. Unfortunately there are but three diseases satisfactorily demonstrated as due to bacteria—charbon, septicæmia, and fowl cholera—and these are yet but imperfectly studied. Zuelzer and Riemschneider found that cultivated bacteria might be introduced under the skin and into the vessels of different animals without producing septic accidents, but that these occurred when 2 to 5 centigrams of neutral sulphate of atropia was added to the matters injected—a proof that a narcotic was sufficient to enable otherwise harmless bacteria to multiply in the tissues.

It is well known that putrefying animal substances, as pus, blood, and water, in which flesh has been macerated, acquire at times the most virulent properties, and a small quantity is even sufficient to destroy a horse. Chauveau has shown that when filtered the filtrates, though eminently poisonous, did not produce local effects, but that this filtrate injected with the bacteria enabled these to produce effects incomparably greater than when the organisms were mixed with water alone. Hiller has also demonstrated that such bacteria filtered from the poisonous liquids and thoroughly washed with water, so as to free them entirely from the poison adhering to them, might be injected into dogs, rabbits, or frogs without producing any effects. It seems to be true, then, that the atmospheric bacteria require the introduction of the narcotic principle with them in order to produce any effect.

The pathogenic bacteria, as I have already shown, are able to multiply with a much more limited supply of oxygen than the septic forms; this is shown by their growing beneath instead of at the surface of cultivations. Perhaps the most important effect produced upon the *Bacillus subtilis* by Buchner's method of cultivation was to enable it to multiply with a more restricted supply of oxygen. Again, we know that it is those septic bacteria which have multiplied in the abdominal liquids in peritonitis and under the skin of horses, where long setons have been introduced, where the free access oxygen is prevented, that are most dangerous. Finally, Professor Law has shown that the swine-plague virus is much more active when grown with a limited supply of air.

As to the accumulation of oxygen in the living body when the bioplasm is narcotized, we know but little, but Chauveau found that when large quantities of charbon virus was injected into the vessels of insusceptible animals the *bacilli* might multiply in local situations, as in the pia mater, and even from spores. Now, as a considerable supply of oxygen is necessary for the formation of spores with this organism, we have here an indication that this supposition is correct.

As to the impossibility of pathogenic bacteria multiplying even in the blood of insusceptible animals we have the testimony of Chauveau, who found that the *Bacillus anthracis* injected into this liquid was arrested in the lungs and spleen; that it was unable to reproduce itself and perished in a very short time.

That the insusceptibility results from the effects of the soluble narcotic and not from the bacteria of themselves seems indicated by this quality being conferred upon the unborn lambs in Chauveau's experiments already alluded to, when it is admitted that the *B. anthracis* does not gain entrance to the fetal circulation.

THE NARCOTIC OF FOWL-CHOLERA VIRUS.

To test the views which are outlined above it is necessary to procure and study the effects of the narcotic principle contained in the virus. Up to this time, I believe, this study has only been accomplished by one man—the accomplished Pasteur. His method was to filter a cultivation liquid through plaster in order to free it from the bacteria, then to evaporate it to dryness at a low temperature and *in vacuo*. The extract thus obtained was dissolved in distilled water, and a quantity, representing four ounces (120 cubic centimeters), of the cultivation liquid was injected subcutaneously in a fowl. This produced after about ten minutes the deep sleep with the rounded outline of body seen in the severe attacks of cholera, but after about four hours these symptoms disappeared and the bird was as well as before.

Unfortunately all investigators are not as happily situated as M. Pasteur in regard to laboratories and apparatus. The writer, for instance, was obliged to evaporate his cultivation liquids over a water-bath and risk the destruction of a part of the constituents that might be volatile at the temperature of boiling water. However, one must make the best of his circumstances, and accordingly I adopted this method with at least partial success, as may be seen from the following experiments:

Experiment No. 59.—November 8 six ounces of virus, cultivated in infusion of chicken muscle, was filtered through paper and evaporated over a water-bath. A brownish extract resulted, which was dissolved in one drachm of distilled water and administered, by hypodermic injection, to a healthy chicken weighing about a pound. Almost immediately there were symptoms of drowsiness, which became very plain after a quarter of an hour. The appearance was exactly that seen in acute attacks of cholera—the bird would assume the sitting posture, close its eyes, and drop into a sound sleep; or, if standing, the ruffled feathers and drooping wings so characteristic of the disease were seen.

What was very remarkable the excrements, which were noticed at the time of the injection, and were then mostly bowel excreta, of normal appearance, within two hours were composed entirely of urates, very liquid, and with a plain, yellow coloration, exactly resembling the excretions in genuine cases of cholera. Eighteen hours after the injection the bird was still somewhat dull and the urates yellowish, but no longer liquid.

This hypodermic injection was followed by complete necrosis of the tissues along the track followed by the needle, and at the point where the liquid was deposited. A hard, dry *sequestrum*, one and one-half inches long, irregularly triangular on cross-section, and of a dark, red color, was formed and was plainly visible through three openings in the epidermis covering it. This *sequestrum* was removed December 8, and in a few days the part was completely healed. The appearance of this lesion and of the *sequestrum* may be seen in Plate X, Figs. 12, 13, and 14.

Experiment No. 60.—November 9.—To test the effect of still larger doses of this toxic element fifteen ounces of cultivation liquid was evaporated over a water-bath without preliminary filtering, and when only a drachm remained this was injected hypodermically into a somewhat larger and much more vigorous bird than that used in the preceding experiment. There was evident dullness within a few minutes; the head and neck were depressed and the feathers erected, giving the rounded outline to the bird so generally assumed by fowls with cholera. The excrement at the time of inoculation was normal, but in fifteen minutes it was being voided very frequently in small quantities, and consisted entirely of liquid kidney excretion. This had the so-called rice-water appearance of some writers, being composed of a transparent mucus-like liquid, somewhat spumuous, and holding in suspension the white urates.

Fourteen hours after the injection the bird was still dull, staggered in walking, the urates were tinted with yellow, but were of normal consistency and amount. For forty-eight hours after the administration of the poison, in both experiments, the birds had the rounded outline and dull appearance seen in cholera. These symptoms gradually disappeared, and the active, healthy aspect returned exactly as before inoculation.

In the case of the bird receiving the larger dose of the extract no *sequestrum* resulted, but comparatively large areas of the skin near the point of the injection became affected with a dry gangrene, which finally gave place to persistent cicatrices. In both cases an affection of the skin was produced over a considerable area surrounding the points of injection, which consisted of small, irregular patches, $\frac{1}{4}$ to $\frac{1}{2}$ inch or more across, where the skin assumed a whitish color and was much thickened.

Experiment No. 61.—A new lot of the extract was prepared December 7 to still further test its properties. Sixty-four ounces of cultivated virus was evaporated to one ounce of extract, forming a sirupy, brownish-looking liquid, with a peculiar but not disagreeable odor. Each of the birds used in the two preceding experiments received a subcutaneous injection of half a drachm of this liquid, which represented four ounces of the active virus. This was followed, as in case of the larger doses, by dullness, erection of the feathers, and somnolence; the last symptom being more noticeable than before, probably owing to the more rapid absorption of the poison. These effects did not continue for the same time, however, having disappeared in five or six hours.

In these cases there was also great irritation at the point of inoculation. The injection was made under the skin of the thigh, and in two or three hours both birds were very lame; there was a puffy swelling covering the whole external surface of the thigh, the skin being white and bloodless. The following day the swelling had nearly disappeared, but the part was of a dark blue, almost black color, which persisted for several days before it entirely disappeared.

Other injections of half this quantity of the poison, diluted with an equal volume of water, caused considerable local irritation, which entirely disappeared in the course of a day or two, without the serious complications which followed the larger doses. The extract representing two ounces of virus still produced sleepiness, but that representing only one ounce had a scarcely noticeable effect.

We have here complete evidence that the bacteria of fowl cholera produce during their multiplication in a harmless liquid a most active poison that has a narcotic action upon the system of the fowl, and which locally is an active irritant, arresting the functions of the animal cells with which it comes in contact, or when sufficiently concentrated even destroying such cells.

INFLUENCE OF THE NARCOTIC ON THE ACTIVITY OF THE VIRUS.

The question which now presented itself for solution was, what is the effect of this narcotic upon the activity of the virus? When we dilute a drop of standard virus with ten thousand times its volume of water, and use but a drop of the dilution for inoculation, we have not only reduced the number of bacteria ten thousand fold but we have at the same time reduced the amount of the narcotic introduced to a like degree. Now, is the mitigation of the effects of the virus due to the small number of bacteria introduced or to the infinitesimal quantity of the poison which remains in a drop of such a dilution? Two or three years ago we should have been obliged to leave such an important question without solution, because our methods of experimenting at that time were not sufficiently perfected to grapple with it; but to-day, thanks to the improvements recently made, we are able to make pure cultivations of virus to any desired amount and to obtain an uncontaminated extract with which to make experiments.

Experiment No. 62.—Two fowls were inoculated by lancet puncture November 28 with standard virus, diluted with 10,000 times its bulk, of a cultivation liquid sterilized by heating to 140°F. for fifteen minutes.

December 3.—Both have local redness.
December 10.—One is sick.
December 19.—Sick one better.
December 21.—Both are well.

Experiment No. 63.—Three fowls of the same lot were inoculated by lancet puncture November 28 with standard virus, diluted with 10,000 times its volume, of a cultivation liquid concentrated over a water-bath to one twenty-fourth of its original bulk.

December 3.—Two have marked local redness.
December 4.—All have the local lesion. One is plainly sick and is isolated.
December 5.—One of the remaining two is sick.
December 8.—The first to sicken is dead; the other is improving.
December 19.—The two remaining fowls are well.

We may compare these experiments with No. 41, which was made with five birds of the same lot, the virus used being the same but diluted with salt solution. The difference in the results is not so great as might be expected. Two out of three sickened and one died where the virus was diluted with the concentrated cultivation liquid; one of two sickened and recovered where the ordinary sterilized cultivation liquid was used for dilution, but even where the dilution was made with the innocent salt solution two out of five died. The only noticeable difference in the effects produced was in the time required for the symptoms to develop themselves. Where the concentrated liquid was used for dilution one fowl sickened in six and the second in seven days from inoculation, while, where the milder cultivation liquid was used, the affected bird did not sicken till the twelfth day, and when the salt solution was used one sickened the twelfth and the second the fourteenth day.

These results, while they do not favor the views of those who maintain that the effects of virus is due rather to the chemical substances secreted by the bacteria than to these organisms themselves, are still exactly what we should expect from a careful study of the other experiments recorded in this report. When we inject the extract of virus into the tissues it is true it may produce most marked results; but unless it is in excessive amount or greatly concentrated the poison is entirely absorbed within a few hours and the effects disappear. Now, when the single drop of extract which adhered to the lancet is introduced with the few bacteria that are contained in it, the bacteria undoubtedly are given a great advantage during the time which elapses before this poison is entirely absorbed. Judging from the multiplication of these microphytes in a cultivation liquid, they will, under favorable conditions, double their number in about one and one-half hours; and as, according to the period of incubation, it requires about eight times as long to double their number in the body of the bird, we have some data—though very insufficient, it is true—for calculating what occurs in such experiments.

If we assume the effects of the poison persist for three hours, and owing to the small quantity introduced it would not be longer than this, the multiplication of the bacteria inserted with the poison must be about as rapid as in the cultivations to obtain the advantage of existing in three times the numbers of the others at the time when the poison has all been absorbed. In other words, it is plain that introducing this concentrated poison with the dilution of 1 to 10,000 could not have a greater effect than trebling the strength of the virus at the start; that is, making it equal to a dilution of 1 to 3,000 in salt solution, which we know a considerable proportion of birds are perfectly able to resist.

The concentration of the chemical products introduced with the bacteria is, therefore, of much less consequence than the number of the parasites, for the latter are producing this poison continually, while that which gains entrance with them is soon absorbed. If a large number of bacteria are placed in the tissues their products at once overwhelm the animal cells nearest to them, allowing their multiplication to continue with considerable rapidity, and before the system has time to become inured to these products they have advanced step by step till the whole body is invaded, and the narcotic is produced in such vast quantities that a recovery becomes next to impossible. On the other hand, when but a few bacteria find their way into the tissues, the poison produced at first is only sufficient to lower the vitality without entirely arresting the functions of the cells; the bacteria increase in number but slowly, and the poison being continually absorbed the cells of the whole body become gradually inured to it; the quantity produced increases so slowly that the advantage is with the animal cells, and before the bacteria have advanced beyond the locality where planted the bird has acquired an immunity, and the parasite is destroyed for want of free oxygen.

THE AMOUNT OF THE CHEMICAL PRODUCTS REQUIRED TO PRODUCE INSUSCEPTIBILITY.

Toussaint, at first, and others since, have concluded that a small amount of the chemical products formed during the multiplication of pathogenic bacteria, if introduced into the system of a susceptible animal, would grant immunity from that particular disease in the future. The amount supposed to be required was only one or two drachms of a cultivation liquid, or of the virulent liquids of the sick or dead body, and this was to be previously devitalized by heating to a sufficient degree to destroy the virulent germs, or by mixing with disinfectants that would insure the same result.

In my last report I detailed eight experiments in which thirty-four fowls were used, and from which I concluded that the devitalized virus, to the amount of two and one-half cubic centimeters (half a drachm), might be injected hypodermically into birds weighing not over two pounds without producing any immunity from the effects of subsequent inoculations. This amount is relatively very much larger than that recommended by the other observers referred to for producing immunity in animals weighing from fifty to two hundred pounds. Toussaint's later experiments, as well as those of Pasteur, made to test the question, have demonstrated that the immunity in such cases was due to a mild attack of the disease which resulted as a consequence of some of the bacteria escaping destruction by the heating process, and that it was in no sense the effect of the small quantity of chemical products injected.

There is good reason to believe, however, though we have no direct experimental evidence of the fact, that the immunity from contagious diseases is really due to the effects of these chemical products, but evidently in much larger doses than has been supposed, and sustained for a considerable time. When a fowl has an attack of cholera it is generally one or two weeks before the signs of recovery are at all plain. Now, if we consider that the virulent liquids in the bird's body represent one-half its weight, it is plain that it is continually under the influence of an amount of the chemical products contained in one to two pints of cultivation or other virulent liquids. But since the effects of the poison contained in one pint of cultivation liquid are only sufficient to keep up its peculiar manifestations for about twelve hours, when this has been injected into the tissues of a healthy bird, we may conclude that during the course of the disease the bird must be subjected every twenty-four hours to at least the amount of poison contained in a quart of virulent cultivation liquid. In ten days this would reach the equivalent of two and one-half gallons of virulent liquid.

In the case of vaccinations with diluted virus, since the multiplication of the bacteria is confined to the locality where introduced, the amount of chemical products developed must be very much less. The reproduction probably occurs in the lymph spaces, but, as the liquid is being continually removed and fresh supplied in its place, there is no data for estimating the quantity acted upon in the course of a day. To produce complete immunity this multiplication goes on for from two to three weeks, or even longer, and therefore the quantity of chemical products poured into the circulation during the whole time must be very considerable. In some cases, however, when the bacteria have reached the general circulation within about a week after the local lesion became apparent, the disease assumed a mild form from the beginning and lasted but a few days, so that a considerable degree of immunity must have been produced in this time. I have made but one experiment on this point, which, so far as it goes, supports the view that a large amount of the chemical products must be required to produce any immunity:

Experiment No. 64.—The two birds on which experiments were made to test the effects of the extract of cultivation liquids, prepared by evaporation over a water-bath, received quantities of this hypodermically as follows:

Date.	Quantity of cultivation liquid represented by the extract. No. 1.	Quantity of cultivation liquid represented by the extract. No. 2.
	Ounces.	*Ounces.*
November 8	6	....
November 9	....	15
December 7	4	4
December 8	6	6
December 9	2	2
December 13	1	1
December 15	2	2
Total	21	30

The quantity of virus represented by the extract administered to these birds was, therefore, very considerable, and many times as much as has been used for the same purpose by investigators. Did this produce any immunity? If inoculated with strong virus and the disease was contracted, the question would not be answered; we could only conclude that complete insusceptibility had not been acquired. As all the other birds of this lot had developed marked local lesions when inoculated with virus diluted from 1 to 2,500 to 1 to 10,000, it was decided to inoculate these with a dilution of 1 to 2,500. If, now, they had acquired complete immunity, no local lesion would develop; while if the immunity was partial, we should see a lesion greater or less, according to circumstances. The inoculation was made by lancet puncture December 21.

December 28.—Both have plain local lesion, though not very marked. The one that received the greater amount of the extract has the plainer lesion, while the other has but a slight swelling, with little enlargement of the blood-vessels.

December 29.—Local lesion very plain in both; there are also general symptoms of the disease, particularly dullness, loss of appetite, and yellow urates.

December 30.—Both very sick.

December 31.—One dead.

January 2.—The second one dies.

It is plain that the extract of virus as made and used in this case did not confer the least immunity from the disease. It would be premature to conclude from this experiment, however, that the chemical products formed by the bacteria are incapable of this effect. It is evident that volatile bodies may have escaped during the concentration at so high a temperature, or, which is more probable, that the extract should, perhaps, be administered in smaller doses, but more frequently and for a greater length of time.

PART IV.—INVESTIGATIONS OF SOUTHERN CATTLE FEVER.

Judging from the knowledge of this disease heretofore acquired, its investigation requires not only the utmost delicacy in the methods of research, but also unusual care to avoid errors in the conclusions reached. If we attempt this investigation within the permanently-infected district, we soon learn that the cattle here have acquired a certain insusceptibility to the affection which destroys their usefulness as experimental animals; and if, to obviate this difficulty, we bring animals for experimental purposes from beyond this district, we know that most of the animals thus introduced contract the disease in a few days or weeks without inoculation. If inoculation experiments are instituted with such cattle the conclusions from them must be most unsatisfactory, if not absolutely worthless; for how can it be known that the disease, if contracted at all, is not spontaneous, or due to germs introduced with the air, food, or drink?

Even the border of the infected district is not free from these objections. The roads and pastures are many of them infected, and though a larger proportion of the cattle are susceptible, it is impossible to say which have been exposed to the contagion. It is true a locality may be selected outside of this district, but near the border the people are already alarmed at the extension of the malady and are unwilling to have it brought on their lands for any reasonable consideration; and at a distance it is found impossible to transport the liquids and organs of dead animals, in the hot days of summer, without their undergoing decomposition—a change which is destructive to most kinds of virus.

As a plan of operation for the short period during which the disease occurs, it was determined to study its characteristics in the early part of the season at Atlanta, by introducing cattle from outside of the infected region; and it was hoped that any fungi in the blood or organs might be discovered either by direct microscopical observation or by cultivation experiments. As the season advanced the studies were to be continued along the border line of the district, with a view of testing such conclusions by inoculation as were reached by the earlier studies.

While at Atlanta I learned what had not before been suspected, that the native cattle of this region are very frequently subject to attacks of this disease, either in isolated cases or in very considerable numbers at a time. It seemed to me that such attacks were mostly confined to the lately introduced breeds, as, for example, the Jerseys, which are now the favorite cattle in this section; but I was assured by the cattle-raisers that the native mongrels were also quite subject to it.

And here I desire to acknowledge my indebtedness to Commissioner Henderson, of the State Agricultural Department, who kindly placed the laboratory and everything connected with it at my disposal; also to Colonel Newman and Dr. Pratt, of the same department, for much information and assistance. To Judge John L. Hopkins, of Atlanta, I am under special obligations for his willingness and evident desire to assist the work at all times with his extensive knowledge and valuable counsel.

July 5 I made an examination of a Jersey heifer fourteen months old that had been dead but three or four hours. She had been purged with salts early in the disease, the impression here being at the time that in all cases where the bowels were thoroughly evacuated and kept in laxative condition the animals would recover. This conclusion is due to the mildness of many cases of the disease at the South, and has little more foundation than that peach-leaf tea, calomel, or other drugs very generally used are specifics. Though not specifics, I hasten to admit that purgatives are quite generally useful, and undoubtedly at times save cases which without them would prove fatal.

In this animal the digestive organs were in an almost normal condition; the contents of the manifolds were moist; the mucous membrane of the fourth stomach but slightly reddened; the duodenum contained considerable bile, but the organ was not changed from its appearance in health. The liver was enlarged and somewhat softened; the gall-bladder greatly distended with thick flocculent bile; the spleen was greatly enlarged, nearly black in color, and on section proved to be greatly disintegrated and of a semi-fluid consistence. The kidneys were in places nearly black and evidently enlarged; the bladder but partially distended, with urine of normal appearance, though during the course of sickness the urine had been red.

At this time my own apparatus was unpacked, and with the kind permission of Professor Land I made a number of vacuum tubes in his laboratory for this occasion, but owing either to too rapid work or to being unaccustomed to the apparatus, most of the tubes did not prove to be vacuums, and but a few could be filled satisfactorily. Unfortunately these few were either cracked or broken on their way to the laboratory, six miles distant.

The next day the contents of the most perfect vacuum tubes were carefully examined. The bile contained very fine spherical granules, single or united by twos, also a few rod bacteria. The blood from the portal vein contained both granules and rod bacteria. The blood from the heart contained only the granules, which stained very imperfectly, if at all, with aniline violet. These granules, while they had the general form of micrococci, were without other than the Brownian movement, and it was impossible to say if they were living organisms or *débris* of tissues or blood globules.

Parts of the liver and spleen were placed in alcohol for a week and then cut into sections and stained with aniline violet or hæmatoxylon and mounted in Canada balsam. These were then carefully examined with both the water immersion and homogeneous immersion lenses (one-fifteenth inch). All of the specimens showed granules similar to those seen in the blood, some being in small clusters, but none stained very deeply with either agent.

Other pieces of these glands were hardened by placing for two weeks in chromic acid and alcohol, after which very thin sections could be cut without difficulty; the appearance of the sections was not changed by the process, however, the granules being in all cases present.

The 20th of August I learned that a Jersey cow had just died at Newnan, 40 miles from Atlanta, and taking the first train I was able to make an examination and fill vacuum tubes with the liquids of the body within about seventeen hours after death. At this time there was no offensive odor or other evidence of decomposition. The mucous membrane of the stomach and intestines was much congested; the liver somewhat discolored, and the blood imperfectly coagulated. The bladder was greatly distended with urine of a bright-red color. The most remarkable change, however, was in the spleen. This organ was of a deep-black color, greatly enlarged, and when a slight cut was made into it most of the contents escaped in the form of a thick, black liquid. Blood from the heart and urine from the bladder, taken in vacuum tubes with suitable precautions, were found to contain several varieties of bacteria, and were consequently useless as a guide to determine the particular organism, if any, which is present in this disease. Incipient putrefaction was evidently in progress at the time of the autopsy.

These were the only *post-mortem* examinations that I had an opportunity of making at Atlanta. My main reliance for fresh material to work with was upon three head of cattle shipped from Tennessee, which arrived June 25, two of which were immediately placed upon a pasture, where they remained until the first of September without exhibiting any symptoms whatever of the disease. The other was kept stabled and also remained in perfect health. Men who had dealt in cattle for years assured me that, as a rule, those brought from Tennessee to Atlanta in summer would sicken in two or three weeks, and that the exceptions were rare indeed. It is possible that the exceptional character of the season had something to do with the healthfulness of these cattle, but it has been supposed that such very hot and dry summers were those in which the disease was most fatal.

The fact that cattle may thus be taken to parts of the infected district and kept two months during the hot summer weather, as was the case with these cattle, or a whole year, as has happened in other instances, indicates that the germs of this malady may not be so universally present as has been supposed. If this should prove true there would be reason to hope that a proper system of disinfection, combined with plowing and burning pastures that are infected, might prevent it among new arrivals or eradicate it entirely.

September 28 I made an autopsy of a cow at Hendersonville, N. C., that had been affected four days with this disease. She died about noon, and was examined between three and five o'clock in the afternoon. The most noticeable lesions were as follows: The fat colored yellow; the blood imperfectly coagulated; the liver enlarged and gall-bladder much distended; the spleen enlarged and of a dark color, but not disorganized; the mucous membrane of the fourth stomach, near the pyloric extremity, was covered with erosions and much congested; the duodenum was also congested; the heart, particularly about the apex, was studded with petechiæ; the bladder was distended with a fluid having about the appearance of venous blood; the kidneys were engorged and of a very dark hue. The manifolds, which many suppose to be constantly impacted with dry, hard food in this disease, were here perfectly normal.

Vacuum tubes were filled from the jugular of this animal and sealed with perfect success. When examined microscopically this blood was remarkable for the small number of red globules, and the very large number of fine granules, which former observers have had little hesitation in pronouncing to be micrococci. Whether this was their nature or not could only be decided by cultivation experiments and not by direct examination. Accordingly a number of cultivation tubes were prepared and charged with infusion of beef, filtered to perfect transparency, and neutralized with liquor potassæ. These were carefully sterilized, and to three was added small portions of the blood. After forty-eight hours in the incubator one became turbid, and on examination was found to contain rods answering to the description of the *Bacillus subtilis;* the other two were under observation for several weeks but remained transparent, and when finally examined were found perfectly free from organisms of any kind. The conclusion was unavoidable that the granules seen in the blood were *débris* of cells, probably of the red corpuscles, and that if the disease was due to a fungus this did not exist in the blood.

The inoculation experiments which I have made will confirm this conclusion, if I mistake not, and will also throw some light upon the nature of the disease. The first of these was made in November, 1879. The material, blood and bile, was obtained from a young bull slaughtered during the progress of the malady, the symptoms being very plain and the hematuria marked. The calf inoculated was six or eight months old, and could by no possibility have ever been previously exposed to the virus. The blood and bile were preserved ten days before an animal could be procured to inoculate, but were still without unpleasant odor; the coagulum of the blood was as perfect as when first formed and the globules were of normal appearance. November 7 this calf was inoculated on the right side of the neck with bile diluted with two parts of water and on the left side with blood diluted to the same extent. Two days later some of the bile and a few drops of the blood were given with the food. No results following, twenty drops of a mixture of the blood and bile diluted with an equal volume of salt solution, were injected hypodermically at the side of the neck. This was on the 14th of November and was followed by a hard, tender swelling and some stiffness of the neck, all of which disappeared within a day or two. This calf remained in good health and certainly had no symptoms of Southern fever. Was the virus of the blood and bile in this case destroyed by long keeping? Or may we assume that the virus, if any exists, does not multiply in these liquids? Evidently we cannot decide such important questions from such an experiment, and we must turn to the later inoculations for more light.

September 14, 1881, I learned of the death of a cow from this disease, three miles from Hendersonville, N. C., and when I arrived at the farm she was already buried, though death had occurred but three or four hours before. However, we opened the pit and I filled a syringe holding 5 cubic centimeters with blood from the jugular, and injected the whole at once into the subcutaneous tissue of the neck of a yearling calf which had been running upon the same range as the cow that had just died. This calf never showed the least symptom of Southern fever. Here, again, there is some reason for doubt as to the interpretation to be given to our experiment. The calf had been running on the same range as the cow, and was probably exposed to the same sources of infection—why had it escaped? Was it in a degree insusceptible, as happens with so many fowls inoculated with cholera virus? Or may we conclude that the blood was free from any virulent principle?

September 29 the following six animals received liquids, which it was supposed might contain the virus either hypodermically or administered with water as a drench. The liquids were obtained the afternoon of the preceding day from the cow, the lesions of which have already been enumerated. The inoculations were made between 9½ and 10½ a. m., or within twenty-two hours after the death of the cow:

No. 1.—Yearling bull. Inoculated by hypodermic injection of 5 cubic centimeters of blood containing scraped pulp of spleen.

No. 2.—Red cow. Hypodermic injection of 5 cubic centimeters of blood, with scraped pulp of spleen; also drenched with a mixture of blood, urine, and bile.

No. 3.—Black heifer. Hypodermic injection of 5 cubic centimeters of bile.

No. 4.—Three-year-old bull. Drenched with one ounce of urine.

No. 5.—Two-year-old steer. Drenched with one ounce of bile.

No. 6.—Spotted cow. Hypodermic injection of 5 cubic centimeters of urine.

The liquids were in all cases injected under the skin of the side of the neck.

These animals were at such a distance from me that daily examinations were impossible, but no symptoms of importance could escape the notice of the attendants, who were familiar with the appearance of cattle affected with this disease.

Within two or three days after inoculation a hard swelling 2 or 3 inches in diameter appeared at the point where the injection of blood and splenic pulp was made in No. 1, and also where the bile was injected into the neck of No. 3. No other symptoms were noticed until October 13, when the red cow was noticeably dull, with emaciated appearance, drooping head and weakness, and unsteadiness of posterior parts. A critical examination was then made of all with the following results:

No. 1.—Swelling size of a goose egg at the point of inoculation, soft and fluctuating; respiration and circulation much accelerated. Temperature 107⅗° F.

No. 2.—Appearance as noted above. Temperature 108°.

No. 3.—Hard swelling at point of inoculation; otherwise no abnormal appearance. Temperature 103⅗°.

No. 4.—Appears well. Temperature 103¼°.

No. 5.—Appears well. Temperature 104°.

No. 6.—Appears well. Temperature 102⅗°.

[The temperature at this examination was taken between 2 and 3 o'clock on a warm day. The next morning the temperature of No. 1 was 106¼° and of No. 2 106⅗°.]

October 17 the temperature of No. 1 was 105°; that of No. 2, 106°; of No. 5, 102⅖° The remaining animals appeared so well that their temperature was not taken.

October 24 the temperature of No. 1 was 102¼°; of No. 2, 104°; and of No. 3, 102⅗°.

The cow evidently had a very severe attack of the disease, and for a time it seemed impossible that she could recover; she was excessively emaciated and scarcely able to walk. The bull, on the contrary, was not very noticeably affected, and had it not been for the high temperature its sickness would have been somewhat doubtful. The remainder of the cattle entirely escaped all symptoms of the disease.

The first question that suggests itself is, why were only two out of the six affected when all received, in one way or another, some of the liquids from the same dead animal? As all of these experimental animals were purchased entirely beyond the infected district, and as ninety per cent. of such cattle are usually susceptible to this disease, we can only conclude that the exemption of four of the animals was due to their not receiving the virus of the disease. In other words, the bile and urine did not contain the disease germs.

It is unfortunate that the animal, which I intended should receive a hypodermic injection of pure blood, escaped from the inclosure before the inoculations were made; but since the urine contains, besides the coloring matters of the blood, more or less perfect red corpuscles as well, I think we may conclude that if the blood were virulent the urine would also be. As the animal which received the urine by the digestive tract and also the one that had an hypodermic injection of a considerable quantity of the same liquid were both unaffected by it, I am inclined to accept this as a confirmation of my previous inoculation and cultivation experiments with blood, and to conclude that this liquid is also free from the virulent principle.

The spleen being the organ that is usually most affected, it is not surprising that its pulp should contain the virus; and in the cases where this was used as the inoculating material, and in only these, was the affection transmitted. These experiments, then, appear, to throw much light upon those characters of the disease which are so peculiar that a celebrated English veterinarian is reported to have spoken of them with an incredulous tone, as being a romance in pathology. I refer, of course, to the well-ascertained facts that cattle from the infected districts, though in the best of health, distribute the disease germs among susceptible cattle which run upon the same pastures, while the really sick animals are incapable of transmitting the disease in any way.

The pastures in the infected district being covered with immense numbers of the disease germs, it is not to be wondered at that the digestive organs of cattle pasturing upon them should become vast reservoirs of such germs from which they are distributed with the excrement. These cattle are insusceptible to the disease, and consequently the germs only multiply within the digestive organs; and it is not difficult to see how such healthy cattle may, for a number of weeks after removal to uninfected districts, continue to distribute the disease germs and to thus destroy all susceptible animals on the same pastures.

The multiplication of the contagious germs, now generally admitted to occur in the alimentary tract in cases of typhoid fever, human and fowl cholera, is sufficient evidence that this theory has nothing improbable about it; indeed, I think it is the only theory that can bear a careful consideration. This much accepted, the first part of our mystery disappears, and we can see very well how the healthy southern cattle may be the means of infecting the pastures to which they are taken.

But if the disease is contracted from the pastures; if it is even inoculable, how can it be that the really sick animals may be placed upon the same pastures with susceptible well ones with such perfect impunity that in thousands of instances but one or two cases have occurred in which the transmission in this manner has been suspected? This has certainly been heretofore an unfathomable problem, but if we accept the results of these experiments this point is now as clear as the other. If the urine and bile are free from the disease germs, and particularly if they do not multiply within the blood-vessels, then their growth must be confined to the lymphatics, probably almost entirely to those of the liver and spleen and the large glands in the abdominal cavity. In that case there is no way in which they could leave the body of the sick animal, and transmission of the disease by ordinary means becomes impossible.

It may be objected to this view, that if the germs multiply in the digestive organs of well animals this should equally occur in the sick ones, and thus pastures would be infected by the one as readily as by the other. The fact, however, that sick animals usually contract the disease on pastures but recently infected would indicate that a much smaller number of germs would be ingested; most of these, perhaps, would find their way into the lymphatics, and the remainder would be in too small number to make headway against the hosts of septic bacteria which always inhabit these organs. This, at least, would be in accordance with what is known of the life-history of many kinds of such minute organisms.

The very marked changes which occur in the blood in cases of Southern fever, particularly the destruction of the red globules, and the passage of their *débris* and dissolved coloring matter into the urine, might also be taken as weighing against my conclusions, and to indicate that the virus must multiply in the blood; but with the little knowledge that we have of the manner in which these phenomena occur such an objection can hardly stand against a number of experiments which mutually confirm each other.

Dr. Stiles, of the Metropolitan Board of Health, concluded, in 1868, that these changes in the blood and the hematuria were explicable on the supposition that bile found its way into the blood-stream in consequence of the distended condition of the gall-bladder and biliary radicles. This is certainly a very plausible theory, and of itself does away with the objection. My own late experiments with fowl cholera show that the bacteria of this disease form a chemical substance which, if injected in large quantities, produces not only the general symptoms of the disease, but, what is very surprising, the marked coloration of the renal excretion as it occurs in this malady. Whether the yellow coloration of this excretion in fowl cholera is due to causes similar to those which produce the red coloration in Southern fever is more than our present knowledge will justify us in saying, but that there is a certain parallel in the two phenomena seems very probable.

With such facts before us, it seems to me I have hardly gone too far in accepting the results of the few experiments I have made, and in concluding from them that the growth of the virus in this disease is confined to the lymphatics, and probably to those of the large internal glands, from which their distribution cannot occur in any ordinary cases.

PART V.—PROGRESS OF THE YEAR IN THE PREVENTION OF CONTAGIOUS DISEASES.

PASTEUR'S METHOD OF VACCINATION.

The great event of the year is undoubtedly the complete success of M. Pasteur's method of vaccination for charbon, a discovery which followed naturally enough from his investigation of the modifications which occur in cultivations of fowl-cholera virus from five to eight months old, but the importance of which cannot be overestimated.

Six years ago the essential nature of the virus in the different contagious diseases was generally considered as an impenetrable mystery, and the phenomena of these diseases were inexplicable by the most ingenious hypotheses. The investigations of Dr. Koch, published in 1876, let in the first ray of light by demonstrating the identity of the *Bacillus anthracis* with the contagion of this disease, and they satisfactorily explained to the scientific mind many phenomena in regard to that particular affection which had before baffled the closest students. These discoveries were the result of laboratory work; they followed from strictly scientific methods of research, and doubts were at once raised in regard to their value. Were investigations in the laboratory with mice of any value to the practical veterinarian who is called upon to face the charbon of sheep and cattle and horses in the open field?

We had been so often baffled in our attempts to prevent and cure this terrible affection which makes such havoc in the flocks and herds of the world, and from which man himself is not exempt, that our impatience was too great, and we looked with some disdain upon explanations of the cause, however plausible they might be, when they were unaccompanied by a tangible remedy. Disappointed so often, we were only to be satisfied by a complete revolution in our knowledge of this class of diseases, a revolution sufficient to bring with it the means of satisfactorily controlling them. We forgot that such revolutions require time.

In a scientific investigation it is necessary to have well-grounded elementary facts from which to work, just as it is necessary to have a substantial foundation upon which to erect a large building. In the latter case it does not matter so much whether we have stone or brick, or even piles driven through many feet of water and mud, if they are only firm at last; and in the former case we have learned that the observations upon mice, rabbits, and Guinea pigs afforded a foundation as valuable as those upon sheep and cattle. In the beginning of such an investigation, when every step of the way must be groped through the most profound ignorance, it is essential to use for experimental purposes such animals as are cheap, quickly obtained, and easily preserved and managed; and when the great principles which underlie all natural phenomena are once revealed, we may proceed to apply our discoveries with a minimum of expense and labor. On the other hand, if we begin with the most difficult part of our work, without the assistance afforded by a knowledge of elementary principles, the chances are that we will only meet with disappointment and failure, as have so many who have attempted an investigation of contagious diseases, but have been too impatient to begin at the foot of the ladder and ascend a single round at a time.

The investigations of Koch were, therefore, of the greatest importance, because they proved the disease was caused by a parasitic bacterium which might be cultivated in suitable apparatus outside of the animal body without losing its virulent properties. Here three points were established, every one of which was necessary before the discovery of Pasteur could be made. With this foundation it was possible to bring out the life-history of the parasite; it was possible to learn that at a certain elevated temperature it would live and multiply without forming spores; it was possible to learn that if maintained at this temperature without renewing the cultivation liquid, for a certain number of days, its vigor would be diminished to such an extent that it could only produce a mild form of the disease, from which the animal would recover and be from that time insusceptible to the most infectious virus. It is thus that one fact leads to another; that discoveries of the greatest importance are only made possible by preceding observations that at the time they are made may be considered of little practical value; and it is by the scrupulous care with which the genuine scientist establishes every observation, and the unbiased record of the same, that the great achievements of modern science are rendered possible.

There were those who doubted the discoveries of Koch, however, as there were others who did not hesitate to discredit those of Pasteur; but how soon was their work to be vindicated, and what a glorious vindication!

The first public experiment was made by Pasteur at *Pouilly-le-Fort*, where the *Société d'Agriculture* of Melun placed at his disposition 58 sheep, 2 goats, and 10 head of cattle. The 5th of May 24 of the sheep, 1 goat, and 6 cows each received a hypodermic injection of five drops of attenuated charbon virus. Twelve days later the same animals received a second inoculation with a virus also attenuated but more virulent than the first. May 31 the protective effects of these inoculations were tested by inoculating the 31 animals mentioned, together with 24 of the sheep that had not been prepared with such vaccinations, the remainder of the cattle and the second goat, with a very virulent virus, prepared from spores that had been preserved in M. Pasteur's laboratory for nearly four years. In forty-eight hours, the 24 sheep and the goat that had not been vaccinated were dead; the four cattle had enormous swellings at the point of inoculation, which, in one case, after a few days, nearly reached to the ground. The vaccinated animals all remained in the most perfect health.

There were still some doubters, however; the virus used at *Pouilly-le-Fort* was a cultivated virus, "a sort of laboratory quintessence," to use the words of M. Bouley; for the majority there was something mysterious about it which made the experiment in a certain degree unsatisfactory. The deadly properties of the blood of charbon victims was well known. Was this laboratory virus equally energetic? Would vaccinated animals resist charbon blood as they resisted the cultivated virus? An official commission was appointed at Chartres to solve this question. Twenty vaccinated sheep were delivered to them, and the results at Chartres were similar to those at *Pouilly-le-Fort*—all the vaccinated were preserved, while, with a single exception, all those not vaccinated were destroyed.

Vaccinations on a large scale were immediately commenced. From figures brought down to October 1, it appears that 160 flocks, comprising 58,900 animals, have been operated upon. Of these, to about every three vaccinated two were left unvaccinated to note the practical effects of the measure; the exact number vaccinated was 33,576, and of the unvaccinated, 21,938. Before vaccination the loss from charbon in these flocks was 2,986 animals. During the vaccination and until the effects were established the loss was 260 head out of the 33,576; and during the same period the loss among the 21,938 reached 366. After the effects of the vaccinations were complete the mortality from charbon in the former group fell to five. Among the unvaccinated group the mortality has continued, but the exact figures were not yet ascertained. In other words, the disease was practically extirpated by the vaccinations.*

When a great discovery is made it is not unnatural to go beyond its first benefits and ask what will be its practical value when sufficient time has elapsed to allow of its general application? Perhaps there is no man better able to judge of this than M. H. Bouley, member of the Institute of France and of the Paris Academy of Medicine, as well as inspector-general of the veterinary schools of France—a man of age and sound judgment, standing at the head of the veterinary profession of the world by reason of his great experience and remarkable abilities. At the recent annual reunion of the five academies of the institute, M. Bouley was selected by the Academy of Sciences to deliver the address from that body. Speaking on this subject, he said:

> Yes, this great mystery of contagion, that the efforts of investigators in the times preceding ours remained powerless to discover, science has just definitely revealed, and has given complete satisfaction, on this point, in that which is the supreme aspiration of man: The knowledge of causes.
>
> It is from this great fact, the discovery of the *rôle* of the infinitely small of the invisible world in the development of contagious diseases, or, to speak more rigorously, in a certain number of those diseases for which the demonstration is complete—it is from this great fact that this other discovery, much greater still, proceeds, that of the transformation under the direction of man of the agent by which they kill into an agent truly protective, since its influence, now beneficial, has for effect, like the vaccine of Jenner, to invest the organism which has received it with a complete immunity against the attacks of the fatal disease.
>
> This is not all, and here we touch upon the great discovery which will be the glory of medicine in this century and in all times; this *microbe* of contagion which we have got hold of, which we have been able to reproduce by the artifice of its cultivation in appropriate liquids and in unlimited quantities, and always with its fatal activity, this *microbe* of fatal virulence, it is possible by causing certain determined influences to act upon it—of which the experimenter is master and that he directs at his will—it is possible to deprive it of the excess of its energy and to make of it, after having lessened its power in the necessary degree, no longer the agent of death but that of preservation; in a word, to transform it into vaccine. And when it has experienced this transformation by the best instituted and most ingeniously conceived of artifices, it is possible to make it the source of *micobes* attenuated like itself, and with which the attenuation has become a specific character.
>
> And these varieties, degenerated from their original power and become beneficent even by their feebleness, it is possible to render indefinitely productive, to seal the produce in hermetic vessels, which, distributed wherever contagion menaces, may serve everywhere by inoculation to protect the susceptible species of animals from contracting this contagion.
>
> In a word, by the command of science the *microbe* which produces death has become a vaccine preserving from its attacks. This is the great discovery! Very great, in fact; for what causes its greatness is not alone the results already attained; it is also the method from which it proceeds, which is susceptible of being generalized, and which, from the results already obtained, authorizes every hope in its fecundity.
>
> To whom comes the glory?
>
> The Institute of France has the right to claim it, for it belongs to a member of the Academy of Sciences. His name is on all your lips.

I have made these quotations from the address of the representative of the French Academy of Science to show what is thought of this discovery by one who is competent to judge it, one who has too often felt the insufficiency of all other known means of combating contagious diseases, and one who has stood by and seen the astonishing success of the vaccinations already referred to. It is not a victory for science alone. What must constitute its chief importance in the view of the

* H. Bouley, Recueil de Médecine Vétérinaire, 1881, pp. 1018–1019.

great mass of mankind is its great practical value; it at once secures the protection of the flocks and herds against a terribly fatal disease, and it accomplishes this at an insignificant expense. Even more than this, perhaps, is the promise which it gives of generalization, for who can estimate the value to the world in human lives and property of a method by which each virus may be transformed into a vaccine and made to protect people as well as animals from those destructive plagues which so frequently cause death and consternation over vast sections of the world?

To France belongs the glory of the discovery. And the eloquent words of M. Bouley assure us that this honor is appreciated in France. Although patriotism might lead us to desire so great an achievement for America, we must admit that the country which gave birth to veterinary schools, that has cherished scientific men and encouraged them in their researches beyond all other nations, that has so substantially aided the investigations of contagious diseases, deserves to have this glory attached to one of its most illustrious and most persistent investigators.

THE AUTHOR'S METHOD OF VACCINATION.

In America we have not been entirely idle, thanks to the appropriations made by Congress for the investigation of this class of diseases. When the writer commenced his experimental studies, but little more than two years ago, his attention was at once turned to the development of a method by which animals might be rendered insusceptible to such plagues. At that time the injection of small quantities of devitalized virus promised to be most successful, judging from the published experiments of M. Toussaint. That this method was entirely inefficient, however, was completely demonstrated, and the conclusions of Toussaint and others shown to depend upon wrong interpretation of the facts observed.

My attention, however, was very early turned to the effect of inoculations made with diluted virus, and as early as July, 1880,* two experiments were made which indicated that this might be an effective method. I mention this claim to priority because it was not until April, 1881, that M. Chauveau's communication was read before the Academy of Science, in which a single successful experiment is recorded with sheep protected against charbon in this way; and a second case, in which animals were supposed to have contracted a mild form of "symptomatic charbon" for a similar reason, though the experiment was accidental and the explanation an after-thought, and for that reason not carrying the conviction that it would had it been designed to test an hypothesis. These experiments were little more conclusive, therefore, than my own, which were made some nine months earlier; and none of them were sufficient to warrant the adoption of so important a theory.

At the time my first experiments were made I was prevented from following them up, because to do this it was necessary to have a virus of standard strength, and this could only be obtained by artificial cultivations. But pure cultivations of virus had never been made in this country, and there was no certainty that they had ever succeeded in the hands of any one but Pasteur. A simple and cheap cultivation apparatus that could be multiplied to any extent must be invented, and in time this was accomplished; a method of sterilizing the cultivation liquid at a temperature not exceeding 212°F. was also necessary, and after a while the plan of intermittent boiling was decided upon.

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* Special report No. 34, p. 30.

After various other delays, this line of experiments was resumed. The cultivated virus proved so much more potent than the animal fluids used in the first experiments that a considerable number of experiments were necessary to furnish an indication of the dilution sufficient to protect without destroying the bird. Again, the experiments were interrupted for several months to investigate the Southern cattle fever, and on attempting to continue them the preserved virus was found to have degenerated, and no longer produced fatal attacks of the disease in any strength. It is, therefore, only at the final revision of this report that I am able to offer experiments which satisfactorily demonstrate that fowl-cholera virus sufficiently diluted produces, instead of a general fever, simply an insignificant local lesion, with no fever, loss of appetite, or other signs of ill-health, and that this local lesion gives an immunity superior to that obtained by a single inoculation with the mitigated virus.

The reason of this exalted immunity is very plain; we have inoculated with potent virus, which from the small number of bacteria introduced gives the system a chance to become inured to the products of bacterial growth before these organisms are sufficiently numerous to enter the general circulation. The bacteria themselves are in no way modified, however, and they continue their multiplication until the subject is insusceptible to their effects and they are destroyed. But being the most vigorous of the virulent bacteria, when the bird is insusceptible to them, it is insusceptible to the most potent virus in the quantities usually absorbed.

The experiments of Chauveau, taken with my own, indicate that this method is capable of generalization to the same extent as that discovered by Pasteur; while the ease and quickness with which the vaccine is prepared, the certainty of effects, the economy of material, and the more perfect protection are points which would appear to make it decidedly superior. Wherever the cholera of fowls is raging a standard cultivation may be made and the vaccine obtained within twenty-four hours; a single drop of such a cultivation will vaccinate ten, twenty, or even forty thousand fowls, and within three weeks from the commencement of the work the most susceptible of our fowls are insusceptible to inoculations with the strongest virus. And this, without any sickness, or even the local necrosis, which Pasteur describes as following vaccinations with his attenuated virus.

Is this, then, a practical means of preventing fowl cholera? Such a question can only be answered by an estimate of the cost of the process. The actual time required for the vaccination is insignificant, as it need not be more than half a minute per fowl; the vaccine is of even less consequence—a single drop of an inexpensive liquid being more than sufficient for all the fowls in many localities. The possible necessity of a second inoculation is a matter of greater moment. In order to make the vaccinations perfectly safe a virus must be used so weak that it may not produce the local lesion in a certain number of the more insusceptible fowls. This is owing to the great difference in the susceptibility of birds, since what will kill one may scarcely affect another; it is an objection that will hold good against any method of vaccination, since the cause of it resides, not in the vaccine used, but in the birds to be operated upon. Hence the necessity of examining the fowls in about twelve or fourteen days after vaccination to determine if the local lesion is produced in all; if there are any in which this has not occurred, these may be inoculated with a stronger virus. After the local lesion has subsided, which occurs in about three weeks, an inoculation may be made with strong virus to insure the completeness of the immunity. In most cases this will be without the least effect, but in a few it may produce a second local lesion or even a slight diarrhea. The fowls have now acquired an immunity from this contagion—an immunity that in the great majority of cases will never desert them; no matter if others are dying all about them with cholera; no matter if the food is soiled with virus, these birds are unaffected by it.

The production of this result would not require more than half a day's time of one man for one hundred fowls, even if three inoculations were made; and if a number clubbed together to obtain the virus the cost of this would only be a trifle. One cent a bird, and a greater part of this for the time of the operator, would cover the whole expense. Could we expect a cheaper remedy?

In this estimate I have considered that the farmers would buy their vaccine from some one who would supply it of a standard strength; the cost should not be great for, say, three hermetically sealed tubes; the vaccinator would then open a tube, add a drop to the proper quantity of the diluting medium, and insert a drop with a lancet under the skin of each fowl—a process so simple that a child of ordinary abilities could perform it.

This method of vaccination, now sufficiently tested to make its success a certainty, and needing but a few more experiments to completely perfect it, is an important addition to the measures for disinfection which were enumerated in the circular letter of February, 1881 (Special report No. 34, p. 314). The great objection to the prevention by disinfection was the necessity for disinfected runs, to which the fowls must be confined in all cases where the surrounding grounds are infected. The cost of these yards and the trouble of disinfecting, together with the objections to confining fowls, were such that this measure has not been generally adopted, notwithstanding its great utility and certainty of results. In presenting this method of vaccination, to be used as a substitute for the disinfection, I have great hopes that the chief obstacles to the prevention of this destructive plague are removed.

Can the method of transforming virus into vaccine by dilution be applied to other contagious diseases? Undoubtedly to those which are non-recurrent, for as regards two of these the observations of Chauveau already referred to indicate that the same principles may be applied. When we succeed in getting hold of the organisms which constitute the various forms of contagia, when we understand the life history of these, and can cultivate them in purity without detriment to their activity, there can be no doubt of our ability to transform these dangerous enemies into our most trusted friends.

For the purpose of measuring the exact degree of susceptibility or immunity of any animal or breed, the dose of standard virus required to produce a certain definite effect is a most valuable and perfect method. We have here a reagent more delicate than many of those upon the chemists' shelves. This test is frequently of the greatest value in such investigations, and the writer takes pleasure in offering it as one more contribution to so complicated a subject.

MEDICAL TREATMENT.

In regard to the treatment of animals when contagious germs have once begun to multiply in their bodies we have little to offer. Our experiments with various disinfectants in large doses have shown these to be useless. The author has hopes, however, that when his theory of immunity is properly worked out we shall not be so powerless in this respect. It has always appeared to him that whereas certain animals were capable of completely resisting these contagia, and others would recover unaided from their attacks, that if we once understood how to assist the natural resistance our efforts would not be attended with such disastrous failure.

If the bacteria require for their multiplication a supply of free oxygen in the lymph greater than is normally present, then a stimulant that would counteract the effect of the virulent narcotic and rouse the animal cells to renewed activity would seem to be required. Now, recent experiments show that the variety of food taken has an extraordinary influence on the development of charbon. Not only are herbivorous animals much more subject to infection than carnivorous ones, but the same animal which is insusceptible when fed upon flesh contracts the disease when upon a vegetable diet. There can be no doubt of the stimulating nature of a flesh diet, probably on account of the large proportion of albuminoid constituents and the absence of starch and sugar. The German experiment stations have clearly shown that the carbhydrates hinder the destruction of the albuminoids in the animal body, but the activity of the living matter of the body must be measured, to a considerable extent, by the destruction of the albuminoids, and hence we may conclude that the carbhydrates depress that activity. Indeed, we need only contrast the sluggishness and lack of force and vitality of those herbivora which feed upon substances rich in starch with the carnivora to be satisfied of the difference, but the demonstration may be made even plainer by feeding the same horse upon a diet with a nutritive ratio of 1:12, and afterward changing this so that the ratio shall be 1:4. The difference in the vigor and energy in the two cases is unmistakable.

It is evident that feeding upon a flesh diet adds no constituent to the body injurious to the *bacilli*, nor does it remove anything necessary to their existence, since these bacteria flourish outside of the body in infusions of flesh. The effect, then, is on the living matter of the animal body; but how could this influence the development of bacteria in the comparatively large accumulations of lymph into which they find their way, except by causing the removal or preventing the accumulation of something necessary to their multiplication—something which is immediately supplied when that lymph comes in contact with the atmospheric air? And what can that something be except oxygen? Here we have an unexpected confirmation of the theory of immunity advanced in this report, and an indication of the valuable results which may be derived from it.

The resistance shown by carnivora cannot be due to the rapid absorption of the oxygen consequent upon the destruction of the albuminoids alone, for this absorption would probably be produced to a greater extent by the oxidation of the carbhydrates of the vegetable food. The amount of free oxygen in the lymph must therefore be dependent rather upon the activity of the living cells than upon the amount necessary to oxidize the nutritive constituents of the food.

Dr. Grawitz has observed that the brain, which is richly supplied with oxygen, is the organ most resistant to bacterial growth, while the kidney, the oxygen requirement of which is small, is least resistant. Just what *rôle* he ascribes to the oxygen supply I have been unable to determine from the published statements of his views. It is plain, however, that if a large supply of oxygen is furnished to the brain the activity of the cells of this organ is sufficient to keep the lymph surrounding them practically exhausted, and to my mind it is to this activity of the cells that the resistance of this organ against such parasites is due, and not to the large supply of oxygen. Dr. Chauveau's experiments by the intravascular injection of large quantities of charbon virus with insusceptible sheep afford the strongest confirmation, if not a complete demonstration, of this view. In these animals the only tissue where the parasites could develop was not the kidney or liver, but the pia mater covering the brain. Now the pia mater is an extremely vascular membrane, and receives practically the same oxygen supply as the brain itself; but owing to the nature of its constituent elements it cannot use the same relative quantity, and hence the lymph, in its spaces, is undoubtedly richer in oxygen than that in any other part of the body. And it is for this reason that when the bacillus can develop nowhere else it finds here a favorable locality; so favorable, indeed, that it occasionally forms spores. Fortunately, when virus gains entrance to the insusceptible organism in the usual way, or in the ordinary quantity, the bacteria do not reach this location so favorable to their development.

To return now to the influence of food, it has been noticed in the investigation of the wool-sorters' disease (charbon) in England that in nearly every case where information was obtainable the development of the urgent symptoms quickly followed the ingestion of an unusual quantity of vegetable food in some form or other; and in the progress of some of the cases, after a remission of the symptoms, a relapse seemed to follow the eating of vegetable food. Information also comes from Constantinople that there, where the external form of the disease at least is well known, the eating of vegetables and fruit during the progress of an attack is regarded as specially dangerous. In regard to epidemic cholera, the theory that eating more or less crude vegetables and fruits was a chief predisposing cause has been frequently advanced.*

All these observations confirm the view that if our treatment of these diseases is so applied as to assist the animal cells in those functions which exercise an injurious influence on the development of such parasites the results of the treatment will be very apparent. Those disinfectants which have been so largely used in such cases, like carbolic, benzoic, and salicylic acids and the sulphites, seem rather to depress the vigor and activity of the animal bioplasm than to stimulate it; they consequently add to the effects of the narcotic produced by the virulent bacteria, and thus assist instead of hindering the development of the pathogenic agent.

When these points come to be better understood it seems very probable that a large supply of albuminoid food, possibly with the addition of artificially-prepared peptones, and certainly with such stimulants as shall prove most beneficial, will be by far the most successful treatment.

These are questions of the most supreme importance, and deserve an early and most searching investigation.

In this section of my report I have only aimed to notice those additions to our knowledge which seem capable of generalization, and which are consequently of unusual importance. Under the proper headings will be found those studies of the pathogenic bacterium of fowl cholera and its poisonous products, of the distribution of the virus, and its destruction by disinfectants, which, taken with my former report, makes this, with perhaps a single exception, the best understood of the contagious fevers. The most neglected point is the pathological histology, because of the time which it would require and the slight promise of practical results.

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* British Medical Journal, 1881, p. 749.

But little more than two years ago, when the writer was called to this investigation, the medical profession was still in the greatest doubt regarding the germ theory of disease; the contagia were considered unsolved and insoluble mysteries; the methods of investigation adopted were crude and unscientific in the extreme, and the results in most cases were far from carrying conviction. The outlook could not be considered as encouraging to one who had witnessed, with disappointment, the many attempts to throw light upon the nature of contagious diseases which had ended in failure, or in which the results were not very well established. The extreme difficulty of obtaining clear demonstrations had been only too often illustrated, and it was not without many misgivings that the investigations were commenced.

Without an equipped pathological or chemical laboratory, and without the delicate and useful apparatus which have assisted European investigators in their work, and with only a microscope, some flasks, test-tubes, glass and caoutchouc tubing, a coal-oil stove, an alcohol lamp, an inoculating lancet, hypodermic syringe, and case of dissecting instruments as an outfit, the work was begun. Considerable time was devoted to isolating and determining the nature of the pathogenic agent in swine plague; nearly a year has been devoted to determining the district in which the Southern cattle fever occurs, in gathering information in regard to its extension, and preliminary investigations of its nature, which are not yet sufficiently advanced to produce practical results. The widespread ravages of fowl cholera led to its early and systematic study. At that time it was not known to be identical with the disease of the same name in Europe; and, indeed, the investigation of it has brought out some striking differences.

Starting with a demonstration of its contagious nature, the investigation has gone on step by step, first to the determination of the virulent parts of the dead birds, and the virulence of the excrements, then to the absorption of the virus from the digestive tract, the non-diffusibility of the virus in the air, the danger of infected habitations, the effect of natural agencies and disinfectants on the virus, the immunity granted by a first attack, the natural insusceptibility of certain fowls, the inefficiency of devitalized virus as a preventive, the symptoms, *post-mortem* appearances and microscopical peculiarities of the blood, the most practical method of cultivating the virus, the demonstration that this was essentially a peculiar bacterium, the ease with which the disease might be arrested by disinfecting with diluted sulphuric acid, the method of measuring the varying susceptibilities of fowls, the effects of the narcotic substance produced by the virulent bacteria, the insufficiency of disinfectants in the internal treatment of the disease, the harmlessness of inoculation with extremely diluted virus, the immunity thus granted, and preliminary investigations of the nature of this immunity.

In these investigations the writer recognized the worthlessness of conclusions made from experiments on a single bird or animal, and has used two, three, and four in the greater part of the experiments, while some of the more difficult questions have required thirty or forty before a definite conclusion could be reached. The most of the conclusions are consequently demonstrated with scientific accuracy, and are no longer to be questioned.

Considered as relating only to a single disease, the importance of the results attained are very satisfactory, but their influence on our knowledge of contagia in general, and on the methods of preventing their effects, it is believed, will be even more productive of good results in the future. In conclusion, the writer feels that something has been done to justify the opinion expressed in his first report, that the science of the nineteenth century is able to grapple with the most complicated questions connected with these plagues. With the means for the work in the proper hands, and the necessary time, the greater part of these contagious fevers may be most effectually controlled, and some will become as surely extinct as those prehistoric animals and plants which are only known by their fossil representatives.

Respectfully submitted.

D. E. SALMON, D. V. M.

ASHEVILLE, N. C., *January* 27, 1882.

INVESTIGATION OF SWINE PLAGUE.

FOURTH REPORT OF DR. H. J. DETMERS.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: I have the honor to submit the following report on the concluding part of my investigation of swine plague, and on my experiments and their results in regard to prophylactics, from December, 1880, to the present date. The investigation and experiments during that time have not been continuous, but were interrupted last winter by other work, on which report has been made.

At the beginning of the investigation it was my first endeavor to ascertain the nature and causes of swine plague, and later to inquire into the means and manner of its propagation. As the results have been given in my previous reports it will not be necessary to give again a detailed account. Since last December it has been my principal aim, in compliance with instructions from the department, to devise, if possible, such means of prevention as may be found effective, easy of application, and at the same time simple enough to be carried out and used by every farmer, for only such means of prevention can be of practical value, especially in a country like ours, which has so few trained veterinary surgeons as to make it impossible for a large majority of stock-raisers to avail themselves of their services. How far I have succeeded is not for me to say; the facts given in the following report will show. Of course my work has not been wholly restricted to finding and testing means of prevention; on the contrary, wherever an opportunity was offered, further inquiry was made into the nature and causes of the disease, the means by and the manner in which it is communicated, and especially into the agencies and conditions which influence and control the great difference observable in the malignancy of the morbid process, for the reason that no reliable means of prevention can be devised unless the disease itself is well understood. But as the results of this part of my work merely confirm the results of my former investigations, it will not be necessary to give the details, except where my latest researches complete the results or correct slight mistakes of my previous work. In such an investigation, especially if reports are made before the whole is completed, slight mistakes are unavoidable and must sometimes be committed if the almost unsurmountable difficulties encountered are taken into consideration.

In regard to the cause or the infectious principle of swine plague, the microscopical and exceedingly minute swine-plague Schizophytes or Microbes, numerous obstacles had to be overcome in studying and ascertaining their characteristics, development or metamorphoses, vitality, means, and manner of propagation, and mode of action. I do not at all claim that our knowledge in regard to them is by any means complete; on the contrary I know we have only just begun to get an idea as to their life and existence, their mode of development and propagation, their means of action, and their great importance in the animal economy. I flatter myself my work has been in the right direction and has somewhat advanced our knowledge of pathogenic Schizophytes or Microbes, which I hope and expect will be vastly increased by future research, especially if our opticians should succeed in improving their objectives and other apparatus of the microscope as much in the next as they have in the past decade, or at least since they introduced objectives with large apertures and homogeneous immersion.

Still, notwithstanding our knowledge in regard to swine-plague Schizophytes is yet in its infancy, it is at this date nearly as complete as that of the much longer known "*Bacillus anthracis*," the cause of anthrax, first discovered by Pollender and Brauell (*cf. Virchow*, *Archiv f. path. Anat. u. Phys. u. f. Klin.*, *Med.*, xi, 2) nearly a quarter of a century ago. As to the main object of my investigation of swine plague, *i. e.*, devising practical means of prevention, a good deal was dictated by the infectiousness of the disease and the means by and the manner in which it is communicated to healthy animals. Besides, my research as to prophylactics has not been one-sided (several indications have been followed), but as it was my aim to devise a prophylactic treatment which shall be both practical and effective, capable of being applied by the average farmer who has neither the means nor inclination to study pathology, those prophylactics which are merely of scientific value, or not within the reach of the farmer, have not been subjected to as thorough a test as those which can be easily applied and promise fully as good if not better results. Of course it would have been very desirable to subject everything promising good results to a critical test, no matter whether merely of scientific interest or of real practical value, because by so doing our knowledge of swine plague could only have been increased. But during last year material of a malignant form was never very abundant, and sometimes could not be found when wanted; and to experiment with a comparatively mild type of the disease, not apt to have in a majority of cases a fatal termination, even if left to its course, could not be of much benefit in any direction. At any rate the results of such experiments could not be considered as reliable. Consequently nearly all the available material was needed for those experiments by which results of really practical importance—benefiting the common farmer and hog-raiser—were expected to be obtained.

Although cases of swine plague were never entirely wanting and could be found at all times in some part of Illinois, the comparatively very mild type prevailing in almost every section where it made its appearance, and the consequent scarcity of really malignant cases, as also the uncommonly slow spreading of the disease, have thrown into my way a great many obstacles and obliged me not only to spend and to lose much time in search of reliable material for experimentation, but sometimes also to interrupt or to leave incomplete some experiments of which interesting results were expected. Besides, a great deal of material found was not available. So, for instance, quite a number of diseased hogs could be found nearly every day in the hands of dealers, or in the stock-yards, but without buying a whole drove or car-load no diseased animal could be obtained, as the removal of a dead animal from the stock-yards is prohibited by its rules. Questioning the dealers in regard to the whereabouts of the disease, or the places from which diseased animals had come, was of no use. They either gave evasive answers, or professed to be ignorant, and some even denied the existence of the disease in animals about ready to die. On my several visits to the stock-yards for the purpose of obtaining material I never failed to see more than one pen containing quite a number of diseased animals, mostly shoats, sometimes not weighing more than 50 or 60 pounds, but was never able to accomplish my object. In a few cases I succeeded in getting information from a commissioner as to the places where swine plague was existing and hogs were dying, but only once such information proved to be accurate. Whether in the other cases my informant was misinformed himself or whether I was deceived I have not been able to learn. So it happened that I was sometimes obliged to go great distances—to southwestern Iowa and to central Missouri—for material.

THE CAUSES OF THE COMPARATIVE MILDNESS AND OF THE SLOWER SPREADING OF SWINE PLAGUE IN 1880–'81.

Having in the above briefly stated the leading points and the circumstances which guided me in my investigation, and in some instances restricted my researches, it may be in place, before I give a detailed account of the experiments made and the results obtained, to submit the facts observed and the conclusions arrived at by inquiring into the agencies and conditions which caused the disease to be of a much milder type and slower in its spreading in 1880–'81 than a few years ago, particularly in 1878–'79, when it was almost everywhere exceedingly fatal and spread with great rapidity. The scarcity of malignant cases of swine plague, due to the prevailing mild type, though very unfavorable to the progress of my experiments in one way, was productive of some good; in another because it led to an inquiry into the causes of its comparative mildness and slow spreading, and the results by showing what means are employed by nature to mitigate the morbid process and arrest the spreading of the plague, and *vice versa*, by what agencies the morbid process becomes malignant and the spreading of the disease rapid, necessarily indicating, to a certain extent at least, the means of prevention which must be used by man. The causes of the greater leniency and the slower spreading of swine plague are several in number, or rather consist in a combination of circumstances, of which one or another may yet have escaped observation or is not fully known as to the extent of its influence. The causes observed may be divided into two classes—one consisting in conditions brought about by natural events and another one due to human interference.

1. *The natural causes.*—Their influence will be more readily understood if a few facts are first stated.

1. The swine-plague Schizophytes or Microbes, in their development and propagation, pass through certain forms, or metamorphoses. The most simple and common form, that of a spherical micrococcus, is followed by that of a zooglœa mass or coccoglia, in which a large number of micrococci are kept together in one mass by being imbedded in an apparently viscous substance—the glia. While yet in this glia a further development takes place; the single micrococci commence to grow—grow endwise—and become double, till finally the glia breaks and the micrococci, most

of them already double, become free. The latter, however, keep on growing or doubling endwise till chains of various lengths are formed. These latter soon break up into shorter ones, or joints, and finally, at least some of these joints develop a lasting spore—are changed into a helobacterium—and the lasting spores, it seems, produce the germs of new micrococci. The swine-plague Schizophytes or Microbes, although possessing great vitality, being almost indestructible by either high or low temperature while in the state of helobacteria or lasting spores, are easily destroyed when in the form of double micrococci or micrococcus chains.

2. My former experiments have shown that an inoculation of a healthy pig with the Schizophytes, contained mostly in micrococcus form, in blood-serum, exudations, and other morbid products, directly from the body of a diseased or dead hog, is much more apt to produce a fatal type of the plague than an inoculation with swine-plague Schizophytes cultivated in an innocent fluid foreign to the organism of a hog; further, they have also shown that an inoculation with infectious material—for instance, lung exudation containing swine-plague Schizophytes mostly in micrococcus form—taken from a really malignant case, but especially if taken while the disease was at its height, or immediately after a fatal termination, is more apt to produce a severe case of swine plague than an inoculation with material (lung exudation) taken from an animal killed while yet in the first stages or affected with a comparatively mild type of the disease.

3. It was also observed that frost or a temperature sufficiently low to prevent or to arrest putrefaction is unfavorable to and even arrests the development and propagation of the swine-plague germ, and keeps it in a dormant state until, if continued for a long time, it destroys its vitality, or at any rate its power to produce mischief.

Last winter was a severe one; the cold was intense and lasting, and the snow, at least here in the west, covered the ground for a long time and to a considerable depth. This interfered with the development of those Schizophytes outside of the body of the animal which were not especially protected by clinging to moist and porous bodies, such as are poor conductors of heat, and at the same time admit just enough air to supply the wants of the Schizophytes. The severe winter, therefore, kept most of these germs outside of the body of a hog in a dormant condition, prevented their change from one state to another, and impaired in that way their vitality until they finally became destroyed. It also happened that when cold weather set in last winter most of the existing cases of swine plague were of a comparatively mild type, or much less malignant than in 1878–'79, as has been explained in my former reports.

Further, at the end of the winter, when the snow melted, a large portion of the whole surface of the land became submerged, and all the streams, big and little, were not only running to their full capacity but were overflowing their banks; therefore, it is probable that most of the Schizophytes which happened to be yet alive on the surface of hog-yards, pastures, &c., were washed away or carried off by the numerous streamlets into creeks and rivers before they could undergo the changes necessary to produce germs and micrococci able to ascend into the air with the aqueous vapors and to come down again with the rain or dew. When the high water subsided several pouring rains occurred, which again flooded the land and undoubtedly washed away a good many of the germs which remained on higher land, and which had not been carried off by the inundations caused by the melting of the snow. Besides, the spring was cold and backward, and thus natural causes retarded the development of everything organic, and the Schizophytes which so far had escaped destruction but had remained in a dormant state for a long time could not have been expected to make rapid and vigorous changes from one state to another. In order to develop and to undergo the changes necessary to propagation they not only need a certain degree of warmth and moisture, but also a change of pabulum and probably of place after a certain cycle of metamorphoses and propagation has been completed. If that cycle is completed, and new pabulum or a change of place is not provided, they become sterile and sink into a dormant state, and no metamorphoses and propagation take place.

According to my observations in regard to swine-plague Schizophytes outside the body of a hog, an occasional change of their nutrient vehicle (pabulum), effected by a temporary rising in the air of the new germs, and may be the micrococci, not only essentially promotes further development and propagation, but is also indispensable.. Such a temporary rising in the air and coming down again with rain and dew, especially with the latter, which in many cases constitutes the only means of locomotion, was almost entirely prevented by the meteorological conditions just mentioned. The continued severe frost and the covering of the ground with deep snow effectually prevented an evaporation of water and consequently a rising of the Schizophyte germs; and the pouring rains and freshets which followed carried off most of the existing Schizophytes before any rising into the air could take place. Hence, during the latter part of last spring, most of the country, at least as far as this State (Illinois) is concerned, had become disinfected, and if it had not been for certain places which provided favorable conditions and afforded protection for the swine-plague Schizophytes, we might have got rid of the disease. But as it was, many hog lots and pastures contained old straw-stacks, &c., and much of the timberland near creeks and the headwaters of the rivers was full of underbrush and of old vegetation, which afforded admirable protection against those meteorological influences so adverse to the propagation of the swine-plague germs, and, as a great deal of just such timbered land is used as hog pastures or hog ranges, a great many disease germs were preserved and survived, though in most places in a somewhat weakened or dormant condition. Only in some places—I shall have occasion to describe a few of them—the Schizophytes were preserved, it seems, in full vigor, and in them, and in them only malignant cases of swine plague could be found, while at all other places where the disease made its appearance the prevailing type was a rather mild one.

After the pouring rains in the spring ceased almost continuous dry weather set in. It was interrupted only by a few light rains and caused the whole season to be exceedingly droughty, until about the latter part of September, when it again commenced to rain. The swine-plague Schizophytes, therefore, which survived the effect of frost and snow in the winter, and were not carried off by the pouring rains and freshets in the spring, in many cases became deprived of an element very essential to their metamorphosis, propagation, and existence—they lacked a sufficiency of moisture. So again it happened that those still existing outside of the organism of a diseased hog survived only in such places as were not easily deprived of moisture by the continued drought, for instance, in old straw-stacks and in timber containing much underbrush and old, rank vegetation. At any rate timber-lots, pastures, and hog-yards containing old straw-stacks constituted the very places in

The accompanying outline map of this region shows the central line dividing the crops, both of wheat and corn, at the four decennial dates.

The movement of thirty years was through 7¾ degrees of longitude. It has not been equal, more than half of the stride having been accomplished in the first ten years. Nor has the march been without retrograde, as the line of equal division of the crop was carried in 1877 fully a third of a degree farther than in 1879, when the Ohio Valley produced 180,000,000 bushels and the entire Northwest only about two-thirds as much on nearly the same area. It is possible that the movement may at some future day tend eastward after the western limit is reached. The receding eastward in 1879 was in consequence of a higher rate of yield in the older winter-wheat States, in part from better cultivation, tile-draining, and wiser management, with the aid of a propitious season. The following statement illustrates the difference in yield:

States.	Winter wheat.		States.	Spring wheat.	
	Bushels.	Bushels per acre.		Bushels.	Bushels per acre.
New York	11,587,766	15.7	Wisconsin	24,884,689	12.8
Pennsylvania	19,462,405	13.5	Minnesota	34,601,030	11.4
Ohio	46,014,869	18.0	Iowa	31,154,205	10.2
Michigan	35,532,543	19.5	Nebraska	13,847,007	9.4
Indiana	47,284,853	18.0	Dakota	2,830,289	10.7
Illinois	51,110,502	15.9			
Total	210,992,938	17.0	Total	107,317,220	11.0

The highest rate of yield in the northwest fails to equal the lowest in the great winter-wheat States east of the Mississippi. It is fair to say that the difference here presented is greater than the average difference of a series of years, yet the causes producing it act with much uniformity and certainty, and the fact enforces an important lesson in wheat husbandry.

Exportation.—The exportation of wheat assumed increased importance during the war period from the high price of gold (wheat being sold virtually for gold), and from the necessity for something in the place of cotton with which to pay for necessarily heavy imports. During those four years the average annual shipments exceeded 50,000,000 bushels. For five years thereafter the annual shipments averaged but 20,000,000. Then a new impetus was given to the trade, first from increased consumption of wheat in an era of progress and prosperity, and afterwards, when a check came to the general prosperity of the great nations of western Europe, several unpropitious seasons in succession caused a largely increased demand on our supply, which, fortunately, was ample for all demands. The high prices which resulted have greatly increased the acreage, which has been doubled in fifteen years. Since 1869 the exportation has never fallen below fifty millions, except in 1871-'72, and for four years past it has averaged 159,000,000 bushels per annum, and an export value of $187,000,000. The foreign shipments of five years have equaled the volume of exports of sixteen previous crops.

Table showing quantities and values of wheat and wheat flour exported from 1859 to 1882, inclusive.

Years.	Wheat.	Wheat-flour.	Total wheat.	Wheat.	Wheat flour.	Total wheat.
	Bushels.	*Barrels.*	*Bushels.*			
1859	3,002,016	2,431,824	13,945,224	$2,849,192	$14,433,591	$17,282,783
1860	4,155,153	2,611,596	15,907,335	4,076,704	15,448,507	19,525,211
1861	31,238,057	4,323,756	50,694,959	38,313,624	24,645,849	62,959,473
1862	37,289,572	4,882,033	59,258,720	42,573,295	27,534,677	70,107,972
1863	36,160,414	4,390,055	55,915,661	46,754,195	28,366,069	75,120,264
1864	23,681,712	3,557,347	39,689,773	31,432,133	25,588,249	57,020,382
1865	9,937,152	2,604,542	21,657,591	19,397,197	27,222,031	46,619,228
1866	5,579,108	2,183,050	15,402,828	7,842,749	18,396,686	26,239,435
1867	6,146,411	1,300,106	11,996,888	7,822,555	12,803,775	20,626,330
1868	15,940,899	2,076,423	25,284,802	30,247,632	20,887,798	51,135,430
1869	17,557,836	2,431,873	28,501,264	24,383,259	18,813,865	43,197,124
1870	36,584,115	3,463,333	52,169,113	47,171,229	21,169,593	68,340,822
1871	34,310,906	3,653,841	50,753,190	45,143,424	24,093,184	69,236,608
1872	26,423,080	2,514,535	37,738,487	38,915,060	17,955,684	56,870,744
1873	39,204,285	2,562,086	50,733,672	51,452,254	19,381,664	70,833,918
1874	71,039,928	4,094,094	89,463,351	101,421,459	29,258,094	130,679,553
1875	53,047,177	3,973,128	70,926,253	59,607,863	23,712,440	83,320,303
1876	55,073,122	3,935,512	72,782,926	68,382,899	24,433,470	92,816,369
1877	40,325,611	3,343,665	55,372,103	47,135,562	21,663,947	68,799,509
1878	72,404,961	3,947,333	90,167,959	96,872,016	25,095,721	121,967,737
1879	122,353,936	5,629,714	147,687,649	130,701,079	29,567,718	160,268,792
1880	153,252,795	6,011,419	180,304,180	190,546,305	35,333,197	225,879,502
1881	150,565,477	7,945,786	186,321,514	167,698,485	45,047,257	212,745,742
1882	95,271,802	5,915,686	121,892,389	112,929,718	36,375,055	149,304,773

OATS.

This crop in 1881 was an exception, the only cereal not seriously impaired by the vicissitudes of the season. It was not a large crop, and scarcely a medium yield. The average was 24.7 bushels per acre, the average for eleven years being 27.6 per acre. This is the lowest rate for that period, with the exception of 22 bushels in 1874. The range was from 22 to 31.6 bushels.

The value was also higher than in any year since 1870, except in 1874, when it was 52 cents. In 1880, when the yield was 25.8 bushels, slightly under an average, the price was 36 cents, precisely the average of eleven years. It would have been somewhat higher but for the extraordinary abundance and unusual cheapness of corn. So when the production of maize fell off 500,000,000 bushels in 1881, the value of oats advanced ten cents per bushel, notwithstanding the yield of 24.7 bushels, in consequence of the still greater advance of corn, these grains being used interchangeably for feeding certain farm animals.

The value per acre for this series of years is found to be about $10 per acre.

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	255,743,000	8,365,809	$102,570,030	40.1	30.5	$12.[illegible]
1872	271,747,000	9,000,769	91,315,710	33.6	30.1	10.14
1873	270,340,000	9,751,700	101,175,750	37.4	27.7	10.37
1874	240,369,000	10,897,412	125,047,530	52.0	22.0	11.47
1875	354,317,500	11,915,075	129,499,930	36.5	29.7	10.86
1876	320,884,000	13,358,908	112,865,900	35.1	24.0	8.44
1877	406,394,000	12,826,148	118,661,550	29.2	31.6	9.25
1878	413,578,560	13,176,500	101,945,830	24.6	31.4	7.74
1879	363,761,320	12,683,500	120,533,294	33.1	28.7	9.50
1880	417,885,380	16,187,977	150,243,565	36.0	25.8	9.28
1881	416,481,000	16,831,600	193,198,970	46.4	24.7	11.47
Total	3,731,500,760	134,995,398	1,347,058,059			
Annual average	339,227,342	12,272,309	122,459,823	36.1	27.6	[illegible]

BARLEY.

This is the only cereal crop of which a supply for home consumption is not produced in this country. While the average production since 1870 has been 36,000,000 bushels, the importation in excess of exports has been about 6,000,000. Its acreage has increased in nearly the same ratio as the area of wheat, yet the supply lags behind demand, failing to keep pace with the increase of the beer manufacture. The crop of 1881 was a small one, averaging 20.9 bushels per acre, about the same as those of 1874 and 1875, and larger than that of 1872; others of the past decade ranging upwards to 24.5 bushels. The influence of price on extension of area is well exemplified in the history of this crop. In 1872 there was a large importation, causing some reduction in price. The next year there was no enlargement of the breadth cultivated, and the price went up from 73.9 cents to 91.5. In 1874, the year following, the expansion exceeded two hundred thousand acres, producing no increase of aggregate product in that year of low yield, so that the price stood at 92.1, and a further enlargement of 200,000 acres followed, bringing the price down to 81.3 cents, which stopped the increase of area, while better crops and larger imports still farther reduced the price. The reduction of 4,000,000 last year sent up the price again from 66.6 to 82.3. The crop statement is as follows:

A noticeable fact in the local distribution of barley cultivation is the large proportion in three districts widely separated—California, New York, and Minnesota—which together produced 23,000,000 of the 41,000,000 bushels grown last year, and 25,000,000 of the 44,000,000 in the census year. In California its distribution is quite general—Alameda, Colusa, Monterey, San Joaquin, Santa Clara, and Sacramento being the counties of largest production, together supplying more than 5,000,000 of the 12,000,000 bushels produced in 1879. In New York, Ontario, Cayuga, Monroe, Yates, Niagara, and Wayne, in the wheat district of Western New York, are the principal factors in production, producing nearly half the crop of the State. In Wisconsin, Rock, Waukesha, Fond du Lac, Jefferson, Sheboygan, Walworth, Washington, and Milwaukee yield a large portion of the crop. In California it is used considerably for feeding, as it is in the East for drinking purposes. Very little is grown in the South.

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	26,718,500	1,177,666	$21,541,777	80.6	22.7	$18 30
1872	26,846,400	1,397,082	19,837,733	73.9	19.2	14 20
1873	32,044,491	1,387,106	29,333,529	91.5	23.1	21 15
1874	32,552,500	1,580,626	29,983,769	92.1	20.6	18 97
1875	36,908,600	1,789,902	29,952,082	81.3	20.6	16 73
1876	38,710,500	1,766,511	25,735,110	66.5	21.9	14 57
1877	34,441,400	1,614,654	22,028,044	64.0	21.3	13 64
1878	42,245,630	1,790,400	24,483,315	58.0	23.6	13 67
1879	40,283,100	1,680,700	23,714,444	58.9	24.0	14 11
1880	45,165,346	1,843,329	30,090,742	66.6	24.5	16 32
1881	41,161,330	1,967,510	33,862,513	82.3	20.9	17 21
Total	397,077,797	17,995,486	290,563,058			
Annual average	36,097,982	1,635,953	26,414,823	73.2	22.0	16 14

RYE.

This crop shared in the disaster that overtook wheat in 1881, and made the lowest yield in ten years. Its average yield is greater than that of wheat, being nearly 14 bushels for a period of years throughout the country, while that of wheat slightly exceeds 12 bushels. Last year the estimated average was 11.6 bushels. The range of the general average is about 4 bushels, or from 11.6 to 15.9 during the past decade. Pennsylvania, Illinois, New York, Wisconsin, and Iowa are the principal factors in the supply of this cereal, producing nearly two-thirds. In the South its real prominence fails to appear in the census record, as it is far more used there for pasturage than for the grain, which is mainly used for seed. The following table is compiled from the records of estimates of this Department:

Calendar year.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	15, 365, 500	1, 069, 531	$12, 145, 646	79. 0	14. 3	$11 36
1872	14, 888, 600	1, 048, 654	11, 363, 693	76. 3	14. 1	10 83
1873	15, 142, 000	1, 150, 355	11, 548, 126	76. 2	13. 1	10 04
1874	14, 990, 900	1, 116, 716	12, 870, 411	85. 8	13. 4	11 52
1875	17, 722, 100	1, 359, 788	13, 631, 900	76. 9	13. 0	10 02
1876	20, 374, 800	1, 468, 374	13, 635, 826	66. 9	13. 8	9 28
1877	21, 170, 100	1, 412, 902	12, 542, 895	59. 2	14. 9	8 87
1878	25, 842, 790	1, 622, 700	13, 592, 826	52. 6	15. 9	8 38
1879	23, 639, 460	1, 625, 450	15, 507, 431	65. 6	14. 5	9 54
1880	24, 540, 829	1, 767, 619	18, 564, 560	75. 6	13. 9	10 50
1881	20, 704, 950	1, 789, 100	19, 327, 415	93. 3	11. 6	10 82
Total	214, 882, 029	15, 431, 189	154, 730, 729			
Annual average	19, 489, 275	1, 402, 835	14, 066, 430	72. 2	13. 9	10 03

BUCKWHEAT.

This crop has a restricted range. It is annually grown to the extent of about 12,000,000 bushels, of which two-thirds are produced in New York and Pennsylvania, for consumption largely as breakfast-cakes in the great cities of the seaboard. A small quantity, however, is annually reported from nearly all the States. In the South its production is extremely limited—restricted to a few experimental patches. Its acreage has nearly doubled in ten years. The crop in 1881 was the smallest ever reported—11.4 bushels per acre. The range has been from this figure up to 20 bushels. The comparison of estimates of eleven years is as follows:

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	8, 328, 700	413, 915	$6, 900, 268	82. 8	20. 1	$16 67
1872	8, 133, 500	448, 497	6, 747, 618	82. 9	18. 1	15 04
1873	7, 837, 700	454, 152	6, 382, 043	81. 4	17. 2	14 05
1874	8, 016, 600	452, 590	6, 477, 885	80. 8	17. 7	14 31
1875	10, 082, 100	575, 530	7, 166, 267	71. 0	17. 5	12 45
1876	9, 668, 800	666, 441	7, 021, 498	72. 6	14. 5	10 53
1877	10, 177, 000	649, 923	6, 998, 810	68. 7	15. 6	10 76
1878	12, 246, 820	673, 100	6, 454, 120	52. 7	18. 2	9 59
1879	13, 140, 000	639, 900	7, 856, 191	59. 8	20. 5	12 28
1880	14, 617, 535	822, 802	8, 682, 488	59. 4	17. 7	10 55
1881	9, 486, 200	828, 815	8, 205, 705	86. 5	11. 4	9 86
Total	111, 784, 955	6, 625, 665	78, 892, 893			
Annual average	10, 157, 723	602, 833	7, 172, 081	70. 6	16. 1	11 37

POTATOES.

Never has there been so disastrous a season for potatoes at that of 1881. The range of estimated yields is from 53.5 bushels per acre in that year to 110.5 in 1875. The average for the period is placed at 84.2 bushels; so that but half a full crop was gathered; in some States scarcely a third of a crop, while a few had two-thirds of a full yield. The price was, of course, higher than ever before, 90.9 cents per bushel, at the date of returns of prices in December, and higher as consumption exhausted the partial supply. The lowest price during the period was 38.9 per bushel, in 1875, the average for eleven years 56.1. The loss of 70,000,000 bushels was severely felt, and could not be made good by importation. Though Irish and Scotch potatoes were sold in every market east and west, and the trade acknowledged to have attained extraordinary proportions, but 8,789,860 bushels were brought in at a cost of $4,660,120, against 2,170,372 bushels the previous year. Six-sevenths of the shortage was not made up, and there was a similar scarcity of root crops of all kinds.

Estimated annual product, acreage, and value of the potato crop of the United States from 1871 to 1881, inclusive.

Year.	Quantity.	Area.	Value.	Value per bushel.	Yield per acre.	Value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	120,461,100	1,220,912	$71,836,671	59.6	98.6	$58 83
1872	113,516,000	1,331,331	68,061,120	59.9	85.2	51 14
1873	106,089,000	1,295,139	74,774,890	70.5	81.9	57 74
1874	105,981,000	1,310,041	71,823,330	67.7	80.9	54 83
1875	166,877,000	1,510,041	65,019,420	38.9	110.5	43 06
1876	124,827,000	1,741,983	83,861,390	67.2	71.6	48 14
1877	170,092,000	1,792,287	76,249,500	44.8	94.9	42 54
1878	124,126,650	1,776,000	73,059,125	58.9	69.9	41 14
1879	181,626,400	1,836,800	79,153,673	43.6	98.9	43 09
1880	167,659,570	1,842,510	81,662,214	48.3	91.0	44 00
1881	109,145,494	2,041,670	99,291,341	90.9	53.5	48 63
Total	1,490,401,214	17,698,714	844,202,474			
Annual average	135,491,019	1,608,974	76,745,679	56.1	84.2	47 08

HAY.

The grass crop, green and dry, is worth more than any other in this country. The hay is worth far less than the pasturage in intrinsic value, and yet grass depastured produces an overwhelming proportion of the growth in flesh of all animals, and bears an important part in the fattening or furnishing of beeves. The following table presents the annual estimates of this Department of the product and value of the hay crop.

Estimated annual product, acreage, and value of the hay crop of the United States from 1871 to 1881, inclusive.

Years.	Quantity.	Area.	Value.	Value per ton.	Yield per acre.	Value per acre.
	Tons.	*Acres.*			*Tons.*	
1871	22,239,400	19,009,052	$351,717,035	$15 81	1.17	$18 50
1872	23,812,800	20,318,936	345,969,079	14 52	1.17	17 03
1873	25,085,100	21,894,084	339,895,486	13 55	1.14	15 52
1874	24,133,900	21,769,772	331,420,738	13 73	1.11	15 22
1875	27,873,600	23,507,964	342,203,445	12 27	1.18	14 56
1876	30,867,400	25,282,797	300,901,252	9 74	1.22	11 90
1877	31,629,300	25,367,708	271,934,950	8 59	1.24	10 72
1878	39,608,296	26,931,300	285,543,752	7 21	1.47	10 60
1879	35,493,000	27,484,991	330,804,494	9 32	1.29	12 04
1880	31,925,233	25,863,955	371,811,084	11 65	1.23	14 38
1881	35,135,064	30,888,700	415,131,366	13 43	1.14	13 43
Total	327,803,093	268,319,259	3,687,332,681	....	....	....
Annual average	29,800,281	24,392,660	335,212,062	11.25	1.22	13 74

CROP ESTIMATES FOR 1881.

Table showing the product of each principal crop of the several States named, the yield per acre, the total acreage, the average price in each State, and the value of each crop, for 1881.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MAINE.					
Indian corn....bushels..	1,064,000	34	31,300	$0 91	$968,240
Wheat....do....	617,000	14.1	43,700	1 56	962,520
Rye....do....	39,000	15	2,600	1 07	41,730
Oats....do....	2,369,000	28.9	82,100	52	1,231,880
Barley....do....	244,000	*22	11,100	85	207,400
Buckwheat....do....	420,000	20.8	20,200	62	260,400
Potatoes....do....	3,342,248	52	64,274	77	2,573,581
Tobacco....pounds..	....	....	....	....	....
Hay....tons..	941,620	.86	1,094,907	12 10	11,393,602
Total....	....	....	1,350,181	....	17,639,303
NEW HAMPSHIRE.					
Indian corn....bushels..	1,262,000	34.2	36,900	87	1,097,940
Wheat....do....	175,000	15.2	11,500	1 56	273,000
Rye....do....	34,000	10.6	3,200	1 05	35,700
Oats....do....	1,030,000	34.7	29,700	52	535,600
Barley....do....	80,000	22.2	3,600	82	65,600
Buckwheat....do....	92,000	20	4,600	75	69,000
Potatoes....do....	1,831,158	63	29,066	80	1,464,926
Tobacco....pounds..	172,551	1,876	92	12	20,706
Hay....tons..	565,577	.90	628,419	11 75	6,645,530
Total....	....	....	747,077	....	10,308,002
VERMONT.					
Indian corn....bushels..	1,990,000	35.7	55,800	86	1,711,400
Wheat....do....	378,000	18	21,000	1 47	555,660
Rye....do....	104,000	16.8	6,200	1 02	106,080
Oats....do....	3,345,000	33.6	99,500	50	1,672,500
Barley....do....	285,000	25.4	11,200	87	247,950
Buckwheat....do....	341,000	20.1	17,000	72	245,520
Potatoes....do....	2,691,620	70	38,466	75	2,018,715
Tobacco....pounds..	132,736	1,562	85	15	19,910
Hay....tons..	1,030,159	1.10	936,508	11 20	11,537,781
Total....	....	....	1,185,759	....	18,115,516
MASSACHUSETTS.					
Indian corn....bushels..	1,406,000	25.1	56,000	88	1,237,280
Wheat....do....	19,000	15.8	1,200	1 50	28,500
Rye....do....	449,000	16.3	27,600	1 12	502,880
Oats....do....	703,000	30.4	23,100	65	456,950
Barley....do....	82,000	25.6	3,200	95	77,900
Buckwheat....do....	73,000	13.3	5,500	75	54,750
Potatoes....do....	1,814,230	55	32,986	1 00	1,814,230
Tobacco....pounds..	5,000,964	1,520	3,291	15	750,144
Hay....tons..	677,832	1.12	605,207	18 60	12,607,675
Total....	....	....	758,084	....	17,530,309
RHODE ISLAND.					
Indian corn....bushels..	327,000	27	12,100	90	294,300
Wheat....do....	260	10.4	25	1 50	390
Rye....do....	16,000	11.4	1,400	1 13	18,080
Oats....do....	164,000	29.2	5,600	67	109,880
Barley....do....	18,500	23.1	800	97	17,945
Buckwheat....do....	1,350	10.8	125	90	1,215
Potatoes....do....	362,880	60	6,048	1 00	362,880
Tobacco....pounds..	....	....	....	....	....
Hay....tons..	78,535	1.15	68,291	17 75	1,393,996
Total....	....	....	94,389	....	2,198,686

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
CONNECTICUT.					
Indian corn....bushels..	1,427,000	25.5	55,900	$0 80	$1,141,600
Wheat....do....	39,000	17.7	2,200	1 42	55,380
Rye....do....	451,000	14.9	30,300	98	441,980
Oats....do....	1,038,000	28.3	36,700	56	581,280
Barley....do....	12,300	19.8	620	1 00	12,300
Buckwheat....do....	146,000	13	11,200	95	138,700
Potatoes....do....	2,083,315	65	32,051	1 02	2,124,981
Tobacco....pounds..	13,763,750	1572	8,753	16	2,202,201
Hay....tons..	569,017	1.00	569,017	17 64	10,037,460
Total....	....	....	746,741	....	16,735,882
NEW YORK.					
Indian corn....bushels..	20,085,000	26.4	761,500	$0 77	$15,465,450
Wheat....do....	10,844,000	13.9	780,200	1 37	14,856,280
Rye....do....	2,820,000	12	234,600	93	2,622,600
Oats....do....	38,160,000	28.8	1,324,700	48	18,316,800
Barley....do....	8,412,000	23.6	355,900	93	7,823,160
Buckwheat....do....	3,338,000	11.9	279,600	82	2,737,160
Potatoes....do....	20,143,914	57	353,402	87	17,525,205
Tobacco....pounds..	6,291,217	1249	5,037	14	880,770
Hay....tons..	5,502,591	1.12	4,913,028	14 55	80,062,699
Total....	....	....	9,007,967	....	160,290,124
NEW JERSEY.					
Indian corn....bushels..	7,829,000	23.2	336,800	77	6,028,330
Wheat....do....	2,018,000	12.7	158,700	1 43	2,885,740
Rye....do....	1,040,000	10.8	96,600	97	1,008,800
Oats....do....	4,052,000	30.7	131,800	49	1,985,480
Barley....do....	4,200	16.8	250	97	4,074
Buckwheat....do....	312,000	9	34,700	1 00	312,000
Potatoes....do....	2,400,960	60	40,016	1 04	2,496,998
Tobacco....pounds..	181,689	1075	169	12	21,802
Hay....tons..	529,370	1.04	509,010	19 75	10,455,057
Total....	....	....	1,308,045	....	25,198,281
PENNSYLVANIA.					
Indian corn....bushels..	34,599,000	25.2	1,374,500	75	25,949,250
Wheat....do....	18,797,000	12.5	1,503,800	1 34	25,187,980
Rye....do....	4,050,000	10.5	386,600	96	3,888,000
Oats....do....	38,579,000	31.8	1,212,700	48	18,517,920
Barley....do....	480,000	21.1	22,700	95	456,000
Buckwheat....do....	2,466,000	10.1	244,000	96	2,367,360
Potatoes....do....	8,811,600	48.0	183,575	97	8,547,252
Tobacco....pounds..	38,805,661	1173	33,080	13	5,044,735
Hay....tons..	2,924,120	1.10	2,658,291	13 53	39,563,344
Total....	....	....	7,619,246	....	129,521,841
DELAWARE.					
Indian corn....bushels..	2,940,000	14.4	204,100	60	1,764,000
Wheat....do....	1,044,000	10.1	102,900	1 40	1,461,600
Rye....do....	6,500	8.1	800	87	5,655
Oats....do....	316,000	18.5	17,100	45	142,200
Barley....do....	....	....	....	....	....
Buckwheat....do....	5,500	13.7	400	98	5,390
Potatoes....do....	172,903	43	4,021	1 00	172,903
Tobacco....pounds..	....	....	....	....	....
Hay....tons..	49,136	1.02	48,173	17 70	869,707
Total....	....	....	377,494	....	4,421,455
MARYLAND.					
Indian corn....bushels..	16,277,000	24.2	671,400	64	10,417,280
Wheat....do....	7,213,000	11.7	618,300	1 35	9,737,550
Rye....do....	285,000	10.8	26,300	1 00	285,000
Oats....do....	1,823,000	19.3	94,600	48	875,040
Barley....do....	6,200	25.8	240	1 10	6,820
Buckwheat....do....	95,000	10	9,500	90	85,500
Potatoes....do....	959,905	47	20,415	1 03	988,702
Tobacco....pounds..	25,869,218	676	38,265	08	2,069,537
Hay....tons..	272,402	.98	277,961	18 00	4,903,236
Total....	....	....	1,756,981	....	29,368,665

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
VIRGINIA.					
Indian corn........bushels..	27,200,000	15	1,809,200	$0 71	$19,312,000
Wheat........do....	7,165,000	8	893,100	1 33	9,529,450
Rye........do....	304,000	6.4	47,700	92	279,680
Oats........do....	4,331,000	7.9	545,800	53	2,295,430
Barley........do....	14,750	15.5	950	1 10	16,225
Buckwheat........do....	153,000	9.7	15,800	73	111,690
Potatoes........do....	1,348,280	40	33,707	86	1,159,520
Tobacco........pounds..	77,649,854	556	139,663	08.6	2,677,907
Hay........tons..	293,000	1.05	279,048	16 72	4,898,960
Total........	....	....	3,768,938	....	44,280,863
NORTH CAROLINA.					
Indian corn........bushels..	26,977,000	11.7	2,307,600	79	21,311,830
Wheat........do....	4,579,000	6.9	662,200	1 49	6,822,710
Rye........do....	376,000	6.2	60,600	97	364,720
Oats........do....	4,081,000	8.1	506,800	62	2,530,220
Barley........do....	2,500	10	250	1 15	2,875
Buckwheat........do....	52,000	9.6	5,400	71	36,920
Potatoes........do....	709,916	38	18,682	70	496,941
Tobacco........pounds..	24,827,532	443	56,071	13.5	3,351,716
Hay........tons..	90,900	1.15	79,043	15 80	1,436,220
Total........	....	....	3,696,146	....	36,354,152
SOUTH CAROLINA.					
Indian corn........bushels..	8,809,000	6.7	1,308,900	99	8,720,910
Wheat........do....	988,000	5.7	173,900	1 65	1,630,200
Rye........do....	32,000	4.5	7,100	1 60	51,200
Oats........do....	3,098,000	11	281,900	97	3,005,060
Barley........do....	16,850	14	1,200	1 20	20,220
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	98,460	30	3,282	71	69,907
Tobacco........pounds..	47,528	248	192	14	6,653
Hay........tons..	2,787	1.10	2,534	17 60	49,051
Total........	....	....	1,779,008	....	13,553,201
GEORGIA.					
Indian corn........bushels..	19,745,000	8.3	2,388,700	97	19,152,650
Wheat........do....	2,933,000	6.1	477,200	1 63	4,780,790
Rye........do....	144,000	6.6	21,900	1 40	201,600
Oats........do....	5,566,000	9.1	612,300	87	4,842,420
Barley........do....	22,000	14.7	1,500	1 25	27,500
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	294,245	35	8,407	60	176,547
Tobacco........pounds..	242,758	242	1,004	14	33,986
Hay........tons..	15,129	1.25	12,103	17 24	260,824
Total........	....	....	3,523,114	....	29,476,317
FLORIDA.					
Indian corn........bushels..	3,170,000	8.8	359,700	1 00	3,170,000
Wheat........do....	480	5.1	95	1 65	792
Rye........do....	3,200	4.9	650	1 60	5,120
Oats........do....	392,000	8.2	47,800	92	360,640
Barley........do....	....	....	....	....	....
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	59,040	40	1,476	55	32,472
Tobacco........pounds..	23,085	216	107	20	4,617
Hay........tons..	164	1.05	156	19 00	3,116
Total........	....	....	409,984	....	3,576,757
ALABAMA.					
Indian corn........bushels..	20,250,000	9.9	2,035,700	97	19,642,500
Wheat........do....	1,479,000	6.6	222,500	1 58	2,336,820
Rye........do....	31,000	5.7	5,400	1 43	44,330
Oats........do....	3,073,000	9.1	337,200	89	2,734,970
Barley........do....	5,780	9.6	600	1 37	7,919
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	366,864	45	7,643	90	330,178
Tobacco........pounds..	466,133	221	2,110	18	83,903
Hay........tons..	10,881	1.20	9,068	16 48	179,319
Total........	....	....	2,620,221	....	25,359,939

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MISSISSIPPI.					
Indian corn........bushels..	17,646,000	11	1,606,200	$0 96	$16,940,160
Wheat........do....	197,000	5.6	34,900	1 60	315,200
Rye........do....	5,250	6.2	850	1 40	7,350
Oats........do....	2,185,000	10.3	211,700	85	1,857,250
Barley........do....	....	....	....	....	....
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	298,320	40	7,458	92	274,454
Tobacco........pounds..	436,010	287	1,519	17	74,121
Hay........tons..	9,072	1.15	7,889	16 47	149,416
Total........	....	....	1,870,516	....	19,617,951
LOUISIANA.					
Indian corn........bushels..	9,693,000	13	745,600	98	9,499,140
Wheat........do....	5,350	3.3	1,600	1 50	8,025
Rye........do....	235,000	8.7	27,100	1 40	329,000
Oats........do....	364,000	13.8	26,400	89	323,960
Barley........do....	....	....	....	....	....
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	203,034	38	5,343	95	192,882
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	35,178	1.10	31,980	16 20	569,884
Total........	....	....	838,023	....	10,922,891
TEXAS.					
Indian corn........bushels..	33,377,000	11.9	2,808,700	99	33,043,230
Wheat........do....	3,339,000	12.7	263,200	1 40	4,674,600
Rye........do....	42,000	14	3,000	1 20	50,400
Oats........do....	8,324,000	26.8	311,100	61	5,077,640
Barley........do....	106,000	19.3	5,500	90	95,400
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	277,440	40	6,936	98	271,891
Tobacco........pounds..	217,950	304	716	18	39,231
Hay........tons..	62,684	1.18	53,122	11 65	730,269
Total........	....	....	3,447,274	....	43,982,661
ARKANSAS.					
Indian corn........bushels..	21,028,000	14.8	1,425,600	94	19,766,320
Wheat........do....	1,017,000	5.2	196,100	1 50	1,525,500
Rye........do....	22,000	6.7	3,300	1 10	24,200
Oats........do....	2,337,000	13.8	168,900	71	1,659,270
Barley........do....	....	....	....	....	....
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	440,484	44	10,011	99	436,079
Tobacco........pounds..	979,922	484	2,023	08.4	82,313
Hay........tons..	23,761	1.20	19,801	15 00	356,415
Total........	....	....	1,825,735	....	23,850,097
TENNESSEE.					
Indian corn........bushels..	36,232,000	12.4	2,915,300	72	26,087,040
Wheat........do....	6,408,000	6.1	1,055,400	1 36	8,714,880
Rye........do....	182,000	5.6	32,500	1 00	182,000
Oats........do....	6,726,000	14.2	472,100	56	3,766,560
Barley........do....	36,000	13.8	2,600	1 06	38,160
Buckwheat........do....	43,000	8.3	5,200	84	36,120
Potatoes........do....	1,394,447	43	32,429	80	1,115,558
Tobacco........pounds..	22,157,300	550	40,286	07.6	1,683,954
Hay........tons..	181,097	1.10	164,634	14 75	2,671,181
Total........	....	....	4,720,449	....	44,295,453
WEST VIRGINIA.					
Indian corn........bushels:	12,980,000	22.7	571,100	74	9,605,200
Wheat........do....	4,413,000	10.5	420,600	1 25	5,516,250
Rye........do....	165,000	9.8	16,900	96	158,400
Oats........do....	2,098,000	16.8	124,800	47	986,060
Barley........do....	10,250	20.5	500	90	9,225
Buckwheat........do....	325,000	10.3	31,500	81	263,250
Potatoes........do....	1,062,720	45	23,616	99	1,052,093
Tobacco........pounds..	2,066,531	503	4,112	08.5	175,655
Hay........tons..	236,985	1.06	223,571	12 85	3,045,257
Total........	....	....	1,416,099	....	20,811,[illegible]

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
KENTUCKY.					
Indian corn ....bushels..	51, 624, 000	17	3, 042, 400	$0 70	$36, 136, 800
Wheat ....do....	8, 625, 000	7. 5	1, 156, 600	1 31	11, 298, 750
Rye ....do....	694, 000	11. 1	62, 300	99	687, 060
Oats ....do....	6, 534, 000	16. 3	400, 500	47	3, 070, 980
Barley ....do....	344, 000	17	20, 200	89	306, 160
Buckwheat ....do....	10, 500	9. 5	1, 100	74	7, 770
Potatoes ....do....	1, 602, 803	37	43, 319	1 00	1, 602, 803
Tobacco ....pounds..	163, 037, 700	700	232, 911	08. 8	14, 347, 316
Hay ....tons..	220, 926	1. 20	184, 105	13 00	2, 872, 038
Total	....	....	5, 144, 435	....	70, 830, 177
OHIO.					
Indian corn ....bushels..	79, 760, 000	25. 4	3, 134, 400	61	48, 653, 600
Wheat ....do....	38, 520, 000	13. 3	2, 902, 100	1 29	49, 690, 800
Rye ....do....	392, 000	13. 1	29, 900	92	360, 640
Oats ....do....	25, 009, 000	27. 7	902, 300	44	11, 003, 960
Barley ....do....	1, 122, 000	16. 4	68, 300	99	1, 110, 780
Buckwheat ....do....	183, 000	8. 4	21, 900	96	175, 680
Potatoes ....do....	4, 674, 459	31	150, 789	1 10	5, 141, 905
Tobacco ....pounds..	35, 419, 913	964	36, 760	08	2, 833, 593
Hay ....tons..	2, 255, 141	1. 05	2, 147, 753	12 90	29, 091, 319
Total	....	....	9, 394, 202	....	148, 062, 277
MICHIGAN.					
Indian corn ....bushels..	25, 068, 000	28	894, 000	63	15, 792, 840
Wheat ....do....	21, 220, 000	10. 9	1, 950, 300	1 25	26, 525, 000
Rye ....do....	271, 000	12. 5	21, 700	91	246, 610
Oats ....do....	18, 057, 000	32. 7	552, 600	46	8, 306, 220
Barley ....do....	1, 249, 000	24. 3	51, 500	93	1, 161, 570
Buckwheat ....do....	468, 000	14. 5	32, 200	90	421, 200
Potatoes ....do....	7, 632, 162	58	131, 589	80	6, 105, 730
Tobacco ....pounds..	87, 706	498	176	12. 5	10, 963
Hay ....tons..	1, 324, 194	1. 15	1, 151, 473	13 15	17, 413, 151
Total	....	....	4, 785, 538	....	75, 983, 264
INDIANA.					
Indian corn ....bushels..	79, 618, 000	21. 8	3, 657, 800	60	47, 770, 800
Wheat ....do....	31, 353, 000	10. 8	2, 903, 100	1 27	39, 818, 310
Rye ....do....	249, 000	10. 2	24, 400	93	231, 570
Oats ....do....	15, 711, 000	23	683, 000	42	6, 598, 620
Barley ....do....	385, 000	26	14, 800	1 05	404, 250
Buckwheat ....do....	79, 000	11	7, 200	99	78, 210
Potatoes ....do....	2, 961, 910	35	84, 626	1 06	3, 139, 625
Tobacco ....pounds..	7, 719, 373	717	10, 760	07. 5	578, 953
Hay ....tons..	1, 374, 694	1. 20	1, 145, 578	12 20	16, 771, 267
Total	....	....	8, 531, 264	....	115, 397, 604
ILLINOIS.					
Indian corn ....bushels..	176, 738, 000	19. 4	9, 096, 600	58	102, 508, 140
Wheat ....do....	26, 822, 000	8. 2	3, 285, 200	1 22	32, 722, 840
Rye ....do....	2, 775, 000	15. 5	179, 300	91	2, 525, 250
Oats ....do....	66, 094, 000	33. 4	1, 979, 400	43	28, 420, 420
Barley ....do....	754, 000	15. 5	48, 800	86	648, 440
Buckwheat ....do....	148, 000	7. 6	19, 500	99	146, 520
Potatoes ....do....	6, 322, 464	48	131, 718	1 05	6, 638, 587
Tobacco ....pounds..	3, 346, 195	661	5, 062	08. 2	274, 387
Hay ....tons..	3, 214, 713	1. 30	2, 472, 856	11 40	36, 647, 728
Total	....	....	17, 218, 436	....	210, 529, 312
WISCONSIN.					
Indian corn ....bushels..	29, 040, 000	27. 6	1, 054, 000	54	15, 681, 600
Wheat ....do....	17, 987, 000	11. 3	1, 595, 300	1 19	21, 404, 530
Rye ....do....	2, 353, 000	14. 3	164, 500	90	2, 117, 700
Oats ....do....	31, 204, 000	28. 6	1, 092, 200	40	12, 481, 600
Barley ....do....	5, 296, 000	24. 5	215, 800	84	4, 448, 640
Buckwheat ....do....	386, 000	12	32, 200	84	324, 240
Potatoes ....do....	7, 221, 600	75	96, 288	84	6, 066, 144
Tobacco ....pounds..	8, 702, 770	860	10, 045	12. 5	1, 087, 846
Hay ....tons..	1, 877, 989	1. 15	1, 633, 034	10 82	20, 319, 841
Total	....	....	5, 893, 367	....	83, 932, 141

Table showing the product of each principal crop, &c., for 1881—Continued

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MINNESOTA.					
Indian corn……bushels..	16, 252, 000	32	508, 500	$0 53	$8, 613, 560
Wheat……do….	35, 952, 000	11. 4	3, 152, 100	1 06	38, 109, 120
Rye……do….	193, 000	14. 7	13, 100	74	142, 820
Oats……do….	23, 760, 000	35. 6	667, 700	43	10, 216, 800
Barley……do….	4, 145, 000	32. 5	127, 700	71	2, 942, 950
Buckwheat……do….	46, 000	12. 4	3, 700	83	38, 180
Potatoes……do….	5, 031, 390	65	52, 962	65	3, 270, 403
Tobacco……pounds..	……	……	……	……	……
Hay……tons..	1, 587, 805	1. 18	1, 345, 597	7 15	11, 352, 806
Total……	……	……	5, 871, 359	……	74, 686, 639
IOWA.					
Indian corn……bushels..	173, 289, 000	25. 8	6, 710, 200	44	76, 247, 160
Wheat……do….	18, 248, 000	6. 6	2, 775, 500	1 06	19, 342, 880
Rye……do….	1, 242, 000	11. 4	109, 200	80	993, 600
Oats……do….	42, 434, 000	26. 2	1, 618, 700	34	14, 427, 560
Barley……do….	3, 498, 000	20. 8	167, 800	74	2, 588, 520
Buckwheat……do….	167, 000	12	13, 900	93	155, 310
Potatoes……do….	6, 541, 150	55	118, 930	1 02	6, 671, 973
Tobacco……pounds..	……	……	……	……	……
Hay……tons..	3, 541, 662	1. 25	2, 833, 330	6 63	23, 481, 219
Total……	……	……	14, 347, 560	……	143, 908, 222
MISSOURI.					
Indian corn……bushels..	93, 069, 000	16. 5	5, 650, 100	65	60, 494, 850
Wheat……do….	20, 399, 000	8. 6	2, 382, 700	1 19	24, 274, 810
Rye……do….	458, 000	11. 8	38, 900	85	389, 300
Oats……do….	22, 783, 000	23. 8	959, 200	45	10, 252, 350
Barley……do….	101, 000	15. 8	6, 400	98	98, 980
Buckwheat……do….	66, 000	12. 5	5, 300	98	64, 680
Potatoes……do….	2, 662, 881	39	68, 279	1 12	2, 982, 427
Tobacco……pounds..	12, 233, 959	877	13, 950	08. 3	1, 015, 418
Hay……tons..	1, 066, 683	1. 10	969, 712	12 50	13, 333, 537
Total……	……	……	10, 094, 541	……	112, 906, 352
KANSAS.					
Indian corn……bushels..	76, 377, 000	18. 2	4, 196, 500	58	44, 298, 660
Wheat……do….	19, 909, 000	9. 1	2, 198, 000	1 05	20, 904, 450
Rye……do….	467, 000	12. 2	38, 200	74	345, 580
Oats……do….	8, 754, 000	19. 8	441, 700	40	3, 501, 600
Barley……do….	243, 000	12. 3	19, 700	75	182, 250
Buckwheat……do….	40, 000	9. 5	4, 200	99	39, 600
Potatoes……do….	2, 627, 586	38	69, 147	1 30	3, 415, 862
Tobacco……pounds..	……	……	……	……	……
Hay……tons..	1, 558, 344	1. 08	1, 442, 911	5 40	8, 415, 058
Total……	……	……	8, 410, 358	……	81, 103, 060
NEBRASKA.					
Indian corn……bushels..	58, 913, 000	27. 4	2, 149, 200	39	22, 976, 070
Wheat……do….	13, 840, 000	7. 1	1, 958, 500	97	13, 424, 800
Rye……do….	424, 000	11. 1	38, 200	71	301, 040
Oats……do….	6, 976, 000	21. 4	325, 300	37	2, 581, 120
Barley……do….	1, 270, 000	8. 9	142, 200	55	698, 500
Buckwheat……do….	17, 000	8. 1	2, 100	97	16, 490
Potatoes……do….	1, 496, 736	48	31, 182	98	1, 466, 801
Tobacco……pounds..	……	……	……	……	……
Hay……tons..	801, 142	1. 20	667, 618	4 50	3, 605, 139
Total……	……	……	5, 314, 300	……	45, 069, 960
CALIFORNIA.					
Indian corn……bushels..	2, 633, 000	27. 2	96, 700	78	2, 053, 740
Wheat……do….	31, 406, 000	12	2, 367, 200	1 03	32, 348, 180
Rye……do….	209, 000	11. 1	18, 800	1 00	209, 000
Oats……do….	1, 548, 000	23. 1	67, 100	60	928, 800
Barley……do….	10, 146, 000	18. 9	537, 000	77	7, 812, 420
Buckwheat……do….	6, 100	17. 9	340	1 00	6, 100
Potatoes……do….	4, 479, 245	85	52, 697	80	3, 583, 396
Tobacco……pounds..	……	……	……	……	……
Hay……tons..	1, 078, 421	1, 35	798, 830	12 20	13, 156, 736
Total……	……	……	3, 938, 660	……	60, 098, 872

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
OREGON.					
Indian corn..................bushels..	101,000	20.2	5,000	$0 75	$75,750
Wheat..........................do....	12,673,000	17.2	738,600	88	11,152,2[illegible]
Rye..............................do....	18,000	20	900	67	12,060
Oats.............................do....	5,278,000	34.6	152,400	43	2,269,540
Barley...........................do....	745,000	25.7	29,000	58	432,100
Buckwheat......................do....	6,750	15	450	1 00	6,75[illegible]
Potatoes........................do....	1,238,895	115	10,773	50	619,44[illegible]
Tobacco.....................pounds..	....	....	....	....	....
Hay.............................tons..	271,511	1 40	193,936	12 08	3,279,[illegible]
Total..................................	....	....	1,131,059	....	17,847,[illegible]
NEVADA.					
Indian corn..................bushels..	13,000	24.8	525	1 00	13,000
Wheat..........................do....	48,000	14.5	3,300	1 20	57,600
Rye..............................do....	....	....	....	....	....
Oats.............................do....	190,000	31.7	6,000	90	171,000
Barley...........................do....	450,000	21.4	21,000	1 20	540,000
Buckwheat......................do....	....	....	....	....	....
Potatoes........................do....	294,300	90	3,270	1 35	397,305
Tobacco.....................pounds..	....	....	....	....	....
Hay.............................tons..	98,729	1 30	75,945	15 00	1,480,935
Total..................................	....	....	110,040	....	2,659,840
COLORADO.					
Indian corn..................bushels..	352,000	25.5	13,800	1 05	369,600
Wheat..........................do....	1,310,000	19.8	66,000	1 33	1,742,3[illegible]
Rye..............................do....	28,000	20	1,400	97	27,16[illegible]
Oats.............................do....	771,000	27.4	28,100	81	624,510
Barley...........................do....	88,000	18	4,900	1 15	101,200
Buckwheat......................do....	....	....	....	....	....
Potatoes........................do....	428,560	80	5,357	1 30	557,128
Tobacco.....................pounds..	....	....	....	....	....
Hay.............................tons..	85,918	1.20	71,594	20 00	1,718,360
Total..................................	....	....	191,151	....	5,140,15[illegible]
TERRITORIES.					
Indian corn..................bushels..	5,761,000	32.2	178,700	95	5,472,950
Wheat..........................do....	11,300,000	17.9	631,200	1 08	12,204,000
Rye..............................do....	96,000	18.8	5,100	87	83,520
Oats.............................do....	7,224,000	28.7	251,500	62	4,478,880
Barley...........................do....	1,487,000	21.3	69,700	84	1,249,080
Buckwheat......................do....	....	....	....	....	....
Potatoes........................do....	2,761,370	101	27,434	70	1,932,959
Tobacco.....................pounds..	....	....	....	....	....
Hay.............................tons..	675,209	1.20	562,667	12 40	8,372,4[illegible]
Total..................................	....	....	1,726,301	....	33,793,[illegible]

Summary for each State, showing the product, the area, and the value of each crop for 1881.

STATES.	CORN.			WHEAT.			RYE.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	1,064,000	31,300	$968,240	617,000	43,700	$962,520	39,000	2,600	$41,730
New Hampshire	1,262,000	36,900	1,097,940	175,000	11,500	273,000	34,000	3,200	35,700
Vermont	1,990,000	55,800	1,711,400	378,000	21,000	555,660	104,000	6,200	106,080
Massachusetts	1,406,000	56,000	1,237,280	19,000	1,200	28,500	449,000	27,600	502,880
Rhode Island	327,000	12,100	294,300	260	25	390	16,000	1,400	18,080
Connecticut	1,427,000	55,900	1,141,600	39,000	2,200	55,380	451,000	30,300	441,980
New York	20,035,000	761,500	15,465,450	10,844,000	780,200	14,856,280	2,820,000	234,600	2,622,600
New Jersey	7,829,000	336,800	6,028,330	2,018,000	158,700	2,885,740	1,040,000	96,600	1,008,800
Pennsylvania	34,599,000	1,374,500	25,940,250	18,797,000	1,508,800	25,187,980	4,050,000	386,600	3,888,000
Delaware	2,940,000	204,100	1,764,000	1,044,000	102,900	1,461,600	6,500	800	5,655
Maryland	16,277,000	671,400	10,417,280	7,213,000	618,800	9,737,550	285,000	26,300	285,000
Virginia	27,200,000	1,809,200	19,312,000	7,165,000	892,100	9,529,450	304,000	47,700	279,680
North Carolina	26,977,000	2,307,600	21,811,830	4,579,000	662,200	6,822,710	376,000	60,600	364,720
South Carolina	8,809,000	1,308,900	8,720,910	988,000	173,900	1,630,200	32,000	7,100	51,200
Georgia	19,745,000	2,388,700	19,152,650	2,933,000	477,200	4,780,790	144,000	21,900	201,600
Florida	3,170,000	359,700	3,170,000	480	95	792	3,200	650	5,120
Alabama	20,250,000	2,035,700	19,642,500	1,479,000	222,500	2,336,820	31,000	5,400	44,330
Mississippi	17,646,000	1,606,200	16,940,160	197,000	34,900	315,200	5,250	850	7,350
Louisiana	9,693,000	745,600	9,499,140	5,350	1,600	8,025	235,000	27,100	329,000
Texas	33,877,000	2,803,700	33,048,230	3,339,000	263,200	4,674,600	42,000	3,000	50,400
Arkansas	21,028,000	1,425,600	19,766,320	1,017,000	196,100	1,525,500	22,000	3,300	24,200
Tennessee	36,232,000	2,915,800	26,087,040	6,408,000	1,055,400	8,714,880	182,000	32,500	182,000
West Virginia	12,960,000	571,100	9,605,200	4,413,000	420,600	5,516,250	165,000	16,900	158,400
Kentucky	51,624,000	3,042,400	36,136,800	8,625,000	1,156,600	11,298,750	694,000	62,300	687,060
Ohio	79,760,000	3,134,400	48,653,600	38,520,000	2,902,100	49,690,800	392,000	29,900	360,640
Michigan	25,068,000	894,000	15,792,840	21,220,000	1,950,300	26,525,000	271,000	21,700	246,610
Indiana	79,618,000	3,657,800	47,770,800	31,353,000	2,903,100	39,818,310	249,000	24,400	231,570
Illinois	176,733,000	9,096,600	102,505,140	26,822,000	3,285,200	32,722,840	2,775,000	179,300	2,525,250
Wisconsin	29,040,000	1,054,000	15,681,600	17,987,000	1,595,800	21,404,530	2,353,000	164,500	2,117,700
Minnesota	16,252,000	508,500	8,613,560	35,952,000	3,152,100	38,109,120	193,000	13,100	142,820
Iowa	173,289,000	6,710,200	76,247,160	18,248,900	2,775,500	19,342,880	1,242,000	109,200	993,600
Missouri	93,069,000	5,650,100	60,494,850	20,399,000	2,382,700	24,274,810	458,000	38,900	389,300
Kansas	76,377,000	4,196,500	44,298,660	19,909,000	2,198,000	20,904,450	467,000	38,200	345,580
Nebraska	58,913,000	2,149,200	22,976,070	13,840,000	1,958,500	13,424,800	424,000	38,200	301,040
California	2,633,000	96,700	2,053,740	31,406,000	2,367,200	32,248,180	209,000	18,800	209,000
Oregon	101,000	5,000	75,750	12,673,000	738,600	11,152,240	18,000	900	12,060
Nevada	18,000	525	18,000	48,000	3,300	57,600	....	....	....
Colorado	352,000	13,800	369,600	1,310,000	66,000	1,742,300	28,000	1,400	27,160
Territories	5,761,000	178,700	5,472,950	11,300,000	631,200	12,204,000	96,000	5,100	83,520
Total	1,194,916,000	64,262,025	759,482,170	383,280,090	37,709,020	456,880,427	20,704,950	1,789,100	19,327,415

Summary for each State, showing the product, the area, and the value of each crop for 1881—Continued.

STATES.	OATS.			BARLEY.			BUCKWHEAT.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	2,369,000	82,100	$1,231,880	244,000	11,100	$207,400	420,000	20,200	$260,400
New Hampshire	1,030,000	29,700	535,600	80,000	3,600	65,600	92,000	4,600	69,000
Vermont	3,345,000	99,500	1,672,500	285,000	11,200	247,950	341,000	17,000	245,520
Massachusetts	703,000	23,100	456,950	82,000	3,200	77,900	73,000	5,500	54,750
Rhode Island	164,000	5,600	109,880	18,500	800	17,945	1,350	125	1,215
Connecticut	1,038,000	36,700	581,280	12,300	620	12,300	146,000	11,200	138,700
New York	38,160,000	1,324,700	18,316,800	8,412,000	355,900	7,823,160	3,338,000	279,600	2,737,160
New Jersey	4,052,000	131,800	1,985,480	4,200	250	4,074	312,000	34,700	312,000
Pennsylvania	38,579,000	1,212,700	18,517,920	480,000	22,700	456,000	2,468,000	244,000	2,367,360
Delaware	316,000	17,100	142,200	....	....	....	5,500	400	5,390
Maryland	1,823,000	94,600	875,040	6,200	240	6,820	95,000	9,500	85,500
Virginia	4,331,000	545,800	2,295,430	14,750	950	16,225	153,000	15,800	111,690
North Carolina	4,061,000	506,300	2,530,220	2,500	250	2,875	52,000	5,400	36,936
South Carolina	3,098,000	281,900	3,005,060	16,850	1,200	20,220	....	....	....
Georgia	5,566,000	612,300	4,842,420	22,000	1,500	27,500	....	....	....
Florida	392,000	47,800	360,640	....	....	....	....	....	....
Alabama	3,073,000	337,200	2,734,970	5,780	600	7,919	....	....	....
Mississippi	2,185,000	211,700	1,857,250	....	....	....	....	....	....
Louisiana	364,000	26,400	323,960	....	....	....	....	....	....
Texas	8,324,000	311,100	5,077,640	106,000	5,500	95,400	....	....	....
Arkansas	2,337,000	168,900	1,659,270	....	....	....	....	....	....
Tennessee	6,726,000	472,100	3,766,560	36,000	2,600	38,160	43,000	5,200	36,120
West Virginia	2,098,000	124,800	986,060	10,250	500	9,225	325,000	31,500	268,250
Kentucky	6,534,000	400,500	3,070,980	344,000	20,200	306,160	10,500	1,100	7,770
Ohio	25,009,000	902,300	11,008,960	1,122,000	68,800	1,110,780	183,000	21,900	175,680
Michigan	18,057,000	552,600	8,306,220	1,240,000	51,500	1,161,570	468,000	32,200	421,200
Indiana	15,711,000	683,000	6,598,620	385,000	14,800	404,250	79,000	7,200	78,210
Illinois	66,664,000	1,979,400	28,420,420	754,000	48,800	648,440	148,000	12,500	146,520
Wisconsin	31,204,000	1,092,200	13,481,660	5,296,000	215,800	4,448,640	386,000	32,200	324,240
Minnesota	23,760,000	667,700	10,216,800	4,145,000	127,700	2,942,950	46,000	3,700	38,180
Iowa	42,434,000	1,618,700	14,427,560	3,498,000	167,800	2,868,520	167,000	13,900	155,310
Missouri	22,783,000	959,200	10,252,360	101,000	6,400	96,960	66,000	5,300	64,680
Kansas	8,754,000	441,700	3,501,600	243,000	19,700	182,250	40,000	4,200	39,600
Nebraska	6,976,000	325,300	2,581,120	1,270,000	142,200	698,500	17,000	2,100	16,490
California	1,548,000	67,100	928,800	10,146,000	537,000	7,812,420	6,100	340	6,100
Oregon	5,278,000	152,400	2,269,540	745,000	29,000	432,100	6,750	450	6,750
Nevada	190,000	6,000	171,000	450,000	21,000	540,000	....	....	....
Colorado	771,000	28,100	624,510	88,000	4,900	101,200	....	....	....
Territories	7,224,000	251,500	4,478,880	1,487,000	69,700	1,240,080	....	....	....
Total	416,481,000	16,831,600	193,198,970	41,161,330	1,967,510	28,808,812	9,486,200	828,815	8,205,705

Summary for each State, showing the product, the area, and the value of each crop for 1881—Continued.

STATES.	POTATOES.			TOBACCO.			HAY.		
	Bushels.	Acres.	Value.	Pounds.	Acres.	Value.	Tons.	Acres.	Value.
Maine	3, 342, 248	64, 274	$3, 573, 531				941, 620	1, 094, 907	$11, 393, 602
New Hampshire	1, 831, 158	29, 066	1, 404, 926	172, 551	92	$20, 706	565, 577	638, 419	6, 645, 580
Vermont	2, 691, 620	38, 466	2, 018, 715	132, 736	85	19, 910	1, 030, 159	936, 508	11, 537, 781
Massachusetts	1, 814, 230	32, 986	1, 814, 230	5, 000, 964	3, 291	750, 144	677, 832	605, 207	12, 607, 675
Rhode Island	362, 880	6, 048	362, 880				78, 535	68, 291	1, 393, 996
Connecticut	2, 083, 315	32, 051	2, 124, 981	13, 763, 759	8, 753	2, 202, 201	569, 017	560, 017	10, 037, 460
New York	20, 143, 914	353, 402	17, 525, 205	6, 291, 217	5, 037	880, 770	5, 502, 501	4, 913, 026	80, 062, 680
New Jersey	2, 400, 900	40, 016	2, 496, 998	181, 689	169	21, 802	520, 270	509, 010	10, 453, 057
Pennsylvania	8, 811, 600	183, 575	8, 547, 252	38, 805, 001	33, 080	5, 044, 735	2, 924, 120	2, 658, 291	39, 563, 344
Delaware	172, 903	4, 021	172, 903				49, 136	48, 173	869, 707
Maryland	959, 905	20, 415	988, 702	25, 869, 218	38, 265	2, 069, 537	272, 462	277, 961	4, 903, 236
Virginia	1, 348, 280	33, 707	1, 159, 520	77, 649, 854	139, 663	6, 677, 907	293, 100	279, 048	4, 898, 960
North Carolina	769, 916	18, 682	496, 941	24, 837, 532	56, 071	3, 351, 716	90, 900	79, 043	1, 436, 220
South Carolina	98, 460	3, 282	69, 907	47, 528	192	6, 053	2, 787	2, 534	49, 051
Georgia	294, 245	8, 407	176, 547	242, 758	1, 004	33, 966	15, 120	12, 103	260, 824
Florida	59, 040	1, 476	32, 472	23, 085	107	4, 617	164	156	3, 116
Alabama	366, 864	7, 643	330, 178	466, 183	2, 110	83, 903	10, 881	9, 068	179, 319
Mississippi	298, 320	7, 458	274, 454	436, 010	1, 519	74, 121	9, 072	7, 889	149, 416
Louisiana	203, 034	5, 343	192, 882				35, 178	31, 980	569, 884
Texas	277, 440	6, 936	271, 891	217, 950	716	39, 231	62, 694	53, 122	730, 269
Arkansas	440, 424	10, 011	436, 079	979, 922	2, 023	82, 313	23, 761	19, 801	356, 415
Tennessee	1, 394, 447	32, 429	1, 115, 558	22, 157, 300	40, 286	1, 683, 954	181, 097	164, 634	2, 671, 181
West Virginia	1, 062, 726	23, 616	1, 052, 003	2, 066, 531	4, 112	175, 655	236, 985	223, 571	3, 045, 257
Kentucky	1, 602, 808	43, 319	1, 602, 803	163, 037, 700	232, 911	14, 347, 316	220, 926	184, 105	2, 872, 038
Ohio	4, 674, 459	150, 789	5, 141, 905	35, 419, 913	36, 760	2, 833, 593	2, 255, 141	2, 147, 753	29, 091, 819
Michigan	7, 632, 162	131, 589	6, 105, 730	87, 706	176	10, 963	1, 324, 194	1, 151, 473	17, 413, 151
Indiana	2, 961, 910	84, 626	3, 139, 625	7, 719, 373	10, 760	578, 952	1, 374, 694	1, 145, 578	16, 771, 267
Illinois	6, 322, 464	131, 718	6, 638, 587	3, 346, 195	5, 062	274, 387	3, 214, 713	2, 472, 856	36, 647, 728
Wisconsin	7, 221, 600	96, 288	6, 066, 144	8, 702, 770	10, 045	1, 087, 846	1, 877, 989	1, 633, 034	20, 319, 841
Minnesota	5, 031, 390	52, 962	3, 270, 403				1, 587, 805	1, 345, 597	11, 352, 806
Iowa	6, 541, 150	118, 930	6, 671, 973				3, 541, 662	2, 833, 330	23, 481, 219
Missouri	2, 662, 881	68, 279	2, 982, 427	12, 233, 960	13, 950	1, 015, 418	1, 066, 683	969, 712	13, 333, 537
Kansas	2, 627, 586	69, 147	3, 415, 802				1, 558, 344	1, 442, 911	8, 415, 058
Nebraska	1, 496, 736	31, 182	1, 466, 801				801, 142	667, 618	3, 606, 139
California	4, 479, 245	52, 697	3, 583, 396				1, 078, 421	798, 830	13, 156, 736
Oregon	1, 238, 895	10, 773	619, 448				271, 511	193, 936	3, 279, 853
Nevada	294, 300	3, 270	397, 305				98, 729	75, 945	1, 480, 935
Colorado	428, 560	5, 357	557, 128				85, 913	71, 594	1, 718, 260
Territories	2, 761, 370	27, 434	1, 932, 959				675, 200	562, 667	8, 872, 480
Total	109, 145, 494	2, 041, 670	99, 291, 341	449, 880, 014	646, 239	43, 372, 336	35, 135, 064	30, 888, 700	415, 131, 366

Table showing the average yield per acre and the price per bushel, pound, or ton of farm products for the year 1881.

STATES.	CORN.		WHEAT.		RYE.		OATS.		BARLEY.		BUCKWHEAT.		POTATOES.		TOBACCO.		HAY.	
	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Pounds.	Price per pound.	Tons.	Price per ton.
																Cts.		
Maine	34.0	$0 91	14.1	$1 56	15.0	$1 07	28.9	$0 52	22.0	$0 85	20.8	$0 62	52	$0 77	......	......	86	$12 10
New Hampshire	34.2	87	15.2	1 56	10.6	1 05	34.7	52	22.2	82	20.0	75	63	80	1,876	12	90	11 75
Vermont	35.7	86	18.0	1 47	16.8	1 02	33.6	50	25.4	87	20.1	72	70	75	1,562	15	1.10	11 20
Massachusetts	25.1	88	15.8	1 50	16.8	1 12	30.4	65	25.6	95	13.3	75	55	1 00	1,520	15	1.12	18 60
Rhode Island	27.0	90	10.4	1 50	11.4	1 13	29.3	67	23.1	97	10.8	90	60	1 00	......	......	1.15	17 75
Connecticut	25.5	80	17.7	1 42	14.9	98	28.3	56	19.8	1 00	13.0	95	65	1 02	1,572	16	1.00	17 64
New York	26.4	77	13.9	1 37	12.0	93	28.8	48	23.6	98	11.9	82	57	87	1,249	14	1.12	14 55
New Jersey	23.2	77	12.7	1 43	10.8	97	30.7	49	16.8	97	9.0	1 00	60	1 04	1,075	12	1.04	19 75
Pennsylvania	25.2	75	12.5	1 34	10.5	96	31.8	48	21.1	95	10.1	96	48	97	1,178	13	1.10	13 53
Delaware	14.4	60	10.1	1 40	8.1	87	18.5	45	......	......	13.7	98	43	1 00	......	......	1.02	17 70
Maryland	24.2	64	11.7	1 35	10.8	1 00	19.3	48	25.8	1 10	10.0	90	47	1 03	676	8	98	18 00
Virginia	15.0	71	8.0	1 33	6.4	92	7.9	53	15.5	1 10	9.7	78	40	86	556	8.6	1.05	16 72
North Carolina	11.7	79	6.9	1 49	6.2	97	8.1	62	10.0	1 15	9.6	71	38	70	443	13.5	1.15	15 80
South Carolina	6.7	99	5.7	1 65	4.5	1 60	11.0	97	14.0	1 20	......	......	30	71	248	14	1.10	17 60
Georgia	8.3	97	6.1	1 63	6.6	1 40	9.1	87	14.7	1 25	......	......	35	60	242	14	1.25	17 24
Florida	8.8	1 00	5.1	1 65	4.9	1 60	8.2	92	......	......	......	......	40	55	216	20	1.05	19 00
Alabama	9.9	97	6.6	1 58	5.7	1 43	9.1	89	9.6	1 37	......	......	48	90	221	18	1.20	16 48
Mississippi	11.0	96	5.6	1 60	6.2	1 40	10.8	85	......	......	......	......	40	92	287	17	1.15	16 47
Louisiana	13.0	98	8.3	1 50	8.7	1 40	18.8	89	......	......	......	......	38	95	......	......	1.10	16 20
Texas	11.9	99	12.7	1 40	14.0	1 20	36.8	61	19.8	90	......	......	40	98	304	18	1.18	11 65
Arkansas	14.8	94	5.2	1 50	6.7	1 10	18.8	71	......	......	......	......	44	99	484	8.4	1.20	15 00
Tennessee	12.4	72	6.1	1 36	5.6	1 00	14.2	56	13.8	1 06	8.8	84	43	80	550	7.6	1.10	14 75
West Virginia	22.7	74	10.5	1 25	9.8	96	16.8	47	20.5	90	10.3	81	45	99	503	8.5	1.06	12 85
Kentucky	17.0	70	7.5	1 31	11.1	99	16.3	47	17.0	89	9.5	74	37	1 00	700	8.8	1.20	13 00
Ohio	25.4	61	13.8	1 29	13.1	92	27.7	44	16.4	99	8.4	96	31	1 10	964	8	1.05	12 90
Michigan	28.0	63	10.9	1 25	12.5	91	32.7	46	24.3	98	14.5	90	58	80	498	12.5	1.15	13 15
Indiana	21.8	60	10.8	1 27	10.2	93	23.0	42	26.0	1 05	11.0	99	35	1 06	717	7.5	1.20	12 20
Illinois	19.4	58	8.2	1 22	15.5	91	33.4	43	15.5	86	7.6	99	48	1 05	661	8.2	1.30	11 40
Wisconsin	27.6	54	11.3	1 19	14.3	90	28.6	40	24.5	84	12.0	84	75	84	866	12.5	1.15	10 82
Minnesota	32.0	53	11.4	1 06	14.7	74	35.6	43	32.5	71	12.4	83	95	65	......	......	1.18	7 15
Iowa	25.8	44	6.6	1 06	11.4	80	26.2	34	20.8	74	12.0	93	55	1 02	......	......	1.25	6 63
Missouri	16.5	65	8.6	1 19	11.8	85	23.8	45	15.8	96	12.5	98	39	1 12	877	8.3	1.10	12 50
Kansas	18.2	58	9.1	1 05	12.2	74	19.8	40	12.3	75	9.5	99	38	1 30	......	......	1.08	5 40
Nebraska	27.4	39	7.1	97	11.1	71	21.4	37	8.9	55	8.1	97	48	98	......	......	1.20	4 50
California	27.2	78	12.0	1 03	11.1	1 00	23.1	60	18.9	77	17.9	1 00	85	80	......	......	1.85	12 20
Oregon	20.2	75	17.2	88	20.0	67	34.6	43	25.7	58	15.0	1 00	115	50	......	......	1.40	12 08
Nevada	24.8	1 00	14.5	1 20	......	......	31.7	90	21.4	1 20	......	......	90	1 85	......	......	1.80	15 00
Colorado	25.5	1 05	19.8	1 33	20.0	97	27.4	81	18.0	1 15	......	......	80	1 30	......	......	1.20	20 00
Territories	32.2	95	17.9	1 08	18.8	87	28.7	62	21.3	84	......	......	101	70	......	......	1.20	12 40

could scarcely be induced to move; one of them was rather profusely bleeding from the nose, a symptom only observed where the disease is malignant. Mr. Postlethwaite said he had used some carbolic acid. I have my doubts about it, but, if he has, it has not been used regularly, or, if used regularly, has probably been given to animals about ready to die. I again emphatically advised strict separation, and pointed out on the premises how it could be done with comparatively little labor, but still it required some labor, some fence-making, and some carrying of water. Those of his pigs which crawl through the defective fence usually make their lair under a large old corn-crib, the same under which last year a great many pigs died. It is in precisely the same condition as a year ago.

Mr. Schaefer was visited next. He, too, had not done a thing by way of separation, and remarked that a strict separation would require too much labor and too much fencing, and might after all not do any good. He had used some carbolic acid, but as his pigs were at liberty to go where they pleased, and were not at all obliged to drink the carbolized water, it is very doubtful whether they ever got much, if any. They undoubtedly took the most of their water for drinking from the numerous mud-puddles and hog-wallows in their range, and may even have gone to the river. Several of Mr. Schaefer's animals had died, and others were diseased. Was unable to determine how many were yet healthy and how many sick, because comparatively few could be found or called together, for their range is extensive, and it was not feeding time. Urged Mr. Schaefer once more to separate the healthy animals from the diseased ones.

My next visit was to Mr. Wise's place. A few pigs had died, but only such as were very sick and already past recovery at my first visit. All those not very sick at the time of my first visit, five days ago, or merely infected, were doing well. My directions had been complied with. Made a *post-mortem* examination of a young pig which was found dead, and was one of those very much diseased at the time of my first visit. It had been sick a long time. Its dam, too, had died of swine plague. Death, as became evident by the *post-mortem* examination, was much more the result of exhaustion than the direct or immediate consequence of the morbid process. The lungs and lymphatic glands presented the usual and characteristic morbid changes; nothing else abnormal, except the heart was very soft and flabby, the capillaries of the auricles injected, and the amount of blood in the organism reduced to a minimum.

At Mr. Wimmer's place, which was next visited, all 17 shoats, separated and under treatment, were doing exceedingly well and gaining in flesh. A few others left in the woods as not worth saving, and had not received treatment, were dead.

August 3.—Went once more to Mr. Postlethwaite's, for, knowing that the disease was prevailing in his herd in a very malignant form, I was anxious to use it for testing my prophylactic treatment, but my efforts were in vain; nothing whatever had been done, the pigs were running at large in the hog pasture in the timber, in the yard, under the old corn-crib, in the field, and even on the public highway, or wherever a fence was not tight enough to prevent their getting through. They were dying rapidly; 15 had died in two days, or since the first instant. With his permission I killed for examination a small, emaciated pig, about 5 months old, which was in the last stage of swine plague and about ready to die. Found all the lymphatic glands, but especially those of the mesenterium, very much enlarged—some of the mesenteric glands measure about an inch in their transverse diameter; two-fifths of the left and about four-fifths of the right lung were more or less hepatized, the hepatization presenting all possible stages from mere infiltration with yet fluid exudation to gray hepatization, about ready to decay. Besides, there was considerable exudation in the chest and in the pericardium. In the abdominal cavity a very large number of well-developed ulcerous tumors of a nearly uniform size, averaging that of a good-sized pea, in the whole colon, and in the cæcum, but more numerous and closer together in the former than in the latter intestine. All were coated on their surface by a dirty, yellowish-looking detritus.

August 6.—Went to Mr. Wimmer's, Mr. Schaefer's, and Mr. Wise's, and passing by Mr. Postlethwaite's place I called in and found that nothing had been done, except he had shut up some of the less affected animals in the pen which a few days ago was occupied by sick animals which had all died there. There were yet 78 animals alive out of the original 126, but over half of those yet alive were very sick and will surely die, while all others, with the possible exception of one single animal, were more or less affected.

At Mr. Schaefer's the same state of affairs prevailed. He had not made any separation, but had used some carbolic acid and also a lot of other things, such as sulphur, lime-water, &c., but as all his pigs had access to numerous hog-wallows, and could even go to the river, it is more than doubtful whether they ever tasted the medicated water in the troughs. Mr. Schaefer's pigs had commenced to die very fast. Found some dead ones by the roadside in hog-wallows.

At Mr. Wise's place things looked different. His herd was separated into small lots. He had originally 55 head of swine, large and small. When the treatment was commenced 30 of these 55 animals were either dead (25) or very sick (5). In all, 28 of these 30 (most of them small pigs) died and two recovered. The rest, 25 animals, did not show plain symptoms of swine plague at the commencement of the treatment; of these only one animal afterward exhibited well-developed symptoms, but is now convalescent. The other 24 are now, August 6, to all appearances perfectly healthy. Twenty-seven in all are alive and doing well.

At Mr. Wimmer's place the 17 shoats which were separated and subjected to treatment, are doing well and improving.

August 15.—Mr. Wimmer's 17 shoats are gaining in flesh, look well, and may be considered as healthy animals. The treatment has been discontinued.

At Mr. Postlethwaite's the dying continues. I met Mr. Postlethwaite in Champaign in the middle of September and learned that of his whole herd, originally consisting of 126 animals, only 8 had survived, and that the remainder are diseased and may yet die.

At Mr. Schaefer's, I have been informed, the dying has ceased, but how many in all have died and how many have survived I have not been able to learn. Probably a separation was made at the eleventh hour. The disease in his herd, as also in Mr. Wise's and Mr. Wimmer's, was of the same malignant type as in Mr. Postlethwaite's herd, and his pigs were, on an average of about the same age, or perhaps a trifle older. I would have visited Mr. Schaefer's place again, but the distance from Champaign is fully 20 miles, and there was hardly any prospect that he would do anything, so I thought it was not worth while.

August 18.—Found an infected herd of swine, suitable for testing my prophylactic treatment, at Squire Reinhardt's place, in Crittenden Township, fourteen miles south and half a mile east of Champaign, or about three miles west of Postlethwaite's place, and nearly the same distance from the Embarras River. Mr. Reinhardt's herd of swine consists of about 60 animals, most of them shoats, and some of them old hogs. On my arrival I found about a dozen animals exhibiting unmistakable symptoms of swine plague. Two had died a day or two before. As at the other places, I advised strict separation and carbolic-acid treatment three times a day, from eight to ten drops for every 100 pounds of live weight, and was assured that my advice should be followed.

August 21.—Another infected herd of swine was found at the farm of Mr. Frederick Geiger, in Mahomet Township, eight miles west of Champaign and toward the Sangamon River. Arriving there I found a herd of about 60 shoats and several older hogs in an artificial grove, where they could get no water except what was drawn from a well and given them. Mr. Geiger had lost three animals a day or two before, and 12 to 15 of the shoats showed plain symptoms of swine plague, but none of them, with the exception, perhaps, of one animal, was in an advanced stage of the disease. Made the same arrangements as at Mr. Reinhardt's in regard to treatment. A separation or a change of place was not insisted upon, because the place, an artificial grove of black-walnut trees, contained no underbrush or old, decaying vegetation, was on high and dry ground, and otherwise unobjectionable. Further, a separation was not deemed necessary because the three animals which died had been promptly removed, and none of those living, with the exception, perhaps, of the one pig mentioned, was very seriously affected.

August 25.—Made my second visit at Mr. Reinhardt's place and found that my directions had been complied with as far as circumstances permitted. The separation, it is true, was not a thorough one, as only one portion of the herd, composed mainly of older animals, and very likely not infected, was kept in a separate yard, while the other portion, composed of shoats, and containing diseased and apparently healthy animals, was kept in the barnyard; but as only two animals had died, which had been promptly removed, and as none of the diseased animals were in a very advanced stage of swine plague, and, further, as no better or more suitable yard or place destitute of water was available, no serious objection could be made to this arrangement, notwithstanding the barnyard was undoubtedly infected. But it was mostly bare ground, and therefore no great danger of a continued influx of the infectious principle was apprehended. The carbolic acid had been faithfully given and all the animals were shut off from any water except what was pumped from a well and offered them in troughs. The whole herd showed improvement; those animals which showed unmistakable symptoms of disease at the time of my first visit were still coughing but acting more lively, and no new cases had occurred. Only one of the affected animals showed slight pumping motions of the flanks, but to no greater extent than at the time of my first visit. Mr. Reinhardt expected to lose nearly his whole herd, and is quite enthusiastic about the success so far achieved.

August 27.—At Mr. Geiger's no new cases had occurred, and those pigs already diseased showed improvement. Some of them were decidedly better and none were worse. My directions had been complied with.

September 4.—Went again to Mr. Geiger's place and found all his pigs doing well; only two showed symptoms of disease, and they were improving. All others may be considered well pigs. The treatment was faithfully executed; eight drops of carbolic acid for every 100 pounds of live weight were given three times a day. This minimum dose was considered sufficient, as Mr. Geiger has a patent arrangement for watering his pigs, which prevents the animals from polluting or spilling the water, so everything that was given was consumed. No losses occurred after the treatment commenced.

September 6.—I was informed of some cases of swine plague in Mahomet, a village about 12 miles west of Champaign, on the Sangamon River; but when I went there I found the herd in question had been disposed of.

September 8.—Went again to Mr. Reinhardt's and found all his pigs doing well. A few were still coughing a little, but they appeared to be otherwise all right, and the cough was evidently less distressing than it had been. Only one pig, the one which showed thumping motions of the flanks on August 25, was yet a little dumpish and still a sick pig. The carbolic-acid treatment had been continued to date.

During my stay in Oquawka, Henderson County, in the fall of 1879, I made a number of successful prophylactic experiments with several infected and diseased herds of hogs in different parts of that county. Afterwards I kept up correspondence with a friend, who from time to time informed me of what was going on in regard to swine plague, and so I learned that several farmers in Henderson County had adopted my prophylactic treatment and succeeded in every instance in checking the progress and the spreading of the disease. I therefore considered it worth while to go there once more and see for myself. Having no important cases on hand nearer home, I went there August 31, and although at that time I was not able to find any infected or diseased herds of swine the favorable reports sent me by my friend were fully confirmed in every instance.

September 21.—Although swine plague occurred this year only in certain localities there was no lack of material in July and August, but on some of the infected farms its progress was stopped by shipping the whole herd; on some it had died out for want of material, and on others its development was checked or interrupted by my measures of prevention, besides the prevailing drought was not favorable to its spreading, and so it happened that in September all my searches and inquiries for recent outbreaks or recently infected herds were fruitless. I did not know where to find new material for further experiments, and finally went to Squire Reinhardt's, in Crittenden Township, who knows everybody in his neighborhood, for information, thinking that in Crittenden Township, especially in the vicinity of the Embarras River, new outbreaks might have occurred. In his own herd the treatment had been discontinued for some time, and no losses had occurred, but I found that he had recently turned all his hogs into another lot or yard, one which contained an old straw-stack, the probable source of the first infection, because that yard had been occupied by the shoats immediately before the first cases of disease occurred. The shoats, which were doing as well as could be desired two weeks ago, appeared, at least some of them, to be slightly affected. I heard several coughing, and observed other slight symptoms which were not present when I last visited them. I advised Mr. Reinhardt to take all his hogs out of that yard, to keep them out as long as the old straw-stack remained, and to put them back where they were before. He promised to do so, and also to send word at once if anything should happen. I have received no word, and therefore conclude he has removed his pigs to the yards formerly occupied, that no new outbreak has occurred, and everything is all right.

Mr. Reinhardt informed me that Mr. Jassy, living about three miles southeast of him, on a large farm near the Embarras River, had recently lost a good many pigs. Mr. Reinhardt and myself went there and found that Mr. Jassy had lost very heavily, but not finding him at home I could not learn the exact number. The remainder of his herd, said to be a mere remnant, had been removed to and was found on a piece of high and dry ground, several acres in extent, but surrounded by a hog-tight fence. This piece of ground was destitute of any water, and the animals in consequence could not get any except what was drawn from a well and given them in troughs. Most of the pigs—in all perhaps fifty—were yet evidently diseased, but more or less convalescent. They were mostly shoats from six to twelve months old; all the younger and smaller pigs, and a good many of the larger ones, I was informed, had died. At date the mortality, it appeared, had ceased, and I saw only two or three which were in a bad condition and very likely to die. Till the removal had been effected the mortality had been very great.

September 27.—I found a diseased herd of swine, though only a small one, in the outskirts of Champaign City, belonging to Mr. Barnard. The herd was divided and each portion was in a separate yard. The first yard contained one aged sow and a litter of ten pigs from three to four months old; the second was occupied by a sow with eight young pigs a few weeks old; the third contained two brood-sows without pigs (they had litters afterward); and the fourth contained a few older hogs. Only the sow and some of her pigs in the second yard exhibited symptoms of swine plague; all the others appeared to be perfectly healthy. When I arrived at the premises, in company with the owner, a little child had opened the gate leading from the first into the second yard, and three of the pigs of the litter of ten, which belonged in the first yard, had availed themselves of the opportunity to get into the second yard, and were busily eating corn which had been refused and left on the ground by the diseased sow. Of course these pigs were immediately driven out and back to where they belonged, but what had happened could not be undone; the three pigs had exposed themselves to a possibility of an infection. As the herd was already separated in four different though adjoining yards a further separation was not necessary, and only the occupants of the first yard, the aged sow and her ten pigs, of which three possibly might have become infected, and the sow and her litter in the second yard, were treated with carbolic acid. They received three times a day ten drops for every hundred pounds of live weight. One circumstance must here be mentioned which is rather favorable to or may possibly effect a communication of the disease to the perfectly healthy occupants of No. 3 and No. 4. The latter are lower than the yard which contains the diseased sow and her litter of pigs, and, joining the same, receive more or less of its drainage.

September 30.—The diseased sow and her pigs are no worse, and none of the other animals have become affected.

October 3.—The continued drought has come to an end, terminated by abundant rains, which have softened the ground and revived vegetation. Mr. Barnard had removed the aged sow and her ten large pigs from yard No. 1—the only one higher than No. 2—to the pasture, or yard No. 4, and finding that they as well as the former occupants of the pasture commenced to turn up the sod, had ringed every one of the 17 animals, and thus performed an operation which is exceedingly dangerous and apt to lead to an infection if swine plague is near. It was therefore concluded to subject the whole herd, now doubly exposed, to the carbolic-acid treatment. The diseased sow, though not otherwise any worse, had become partially paralyzed in the hind quarters, and was lame in one fore leg. Her temperature was 104⅘°F. Two of her pigs seem to be worse; one of them gasps for breath and the other one is panting. The other pigs of the same litter seem to be very little ailing, if any; they are quite lively, do not show any plain symptoms of disease, and are only thin, perhaps because they do not get enough milk and are too small to eat much. Although the ground occupied by the healthy swine receives the drainage—to a large extent at least—from the infected yard, the heavy and continuous rains of the last few days have probably been sufficient to entirely wash away every swine plague Schizophyte. It rained nearly four days without interruption.

October 5.—The diseased sow has some appetite, and her paralysis is a little better, but her lameness in one fore leg is about the same. At Mr. Barnard's solicitation I killed, by bleeding, the two sick pigs, which neither of us expected would ever be worth anything, even if they should survive. *Post-mortem* examination: Externally, no morbid changes. Internally, some hepatization and a good deal of fluid exudation in both lungs; and the lymphatic glands, especially those of the mesenterium, very much enlarged, but much more in the pig first killed than in the one killed last. No other morbid changes in either pig. The two *post-mortem* examinations were desirable in so far as they established beyond a doubt that the disease in question was veritable swine plague, and nothing else. So far none of the other pigs, except those belonging to the diseased sow, have shown any symptom whatever.

October 10.—Mr. Barnard's swine are doing well; the diseased sow is improving, her appetite is good, and her lameness and partial paralysis have almost entirely disappeared. Her pigs, too, have grown and look better, and none of the other animals have shown any indication of disease.

October 20.—All the animals are doing well; every trace of swine plague has disappeared; the carbolic-acid treatment was discontinued a few days ago.

In the foregoing I have endeavored to restrict myself to an account of completed experiments, and to leave out as much as possible the details of my futile efforts to obtain material and unsuccessful attempts to find diseased or infected herds of swine suitable for experiment. I have also considered it unnecessary, and as serving no purpose, to give an account of every case in which the animals were shipped or sold before a fair test could be made or before any results could be expected.

RESULTS AND CONCLUSIONS.

As before stated, my principal object was to find and to test, in compliance with my instructions, such prophylactics or means of prevention as are practical or sufficiently simple and easy of application to be intelligently applied by every farmer and swine-raiser. Of course such means, no matter in what they may consist or how they may act, must not be very expensive and must not be injurious to the hog, or at any rate, if not perfectly innocent to the animal, the damage produced must be insignificant and not be of a permanent character. Swine-raising, like all other branches of farming, is a matter of dollars and cents, and if swine plague is successfully prevented only by means which destroy or seriously impair the future usefulness of the animal, or cost perhaps as much as the pig is worth, or which are very difficult of application and require much labor, attention, or study, and may be the use of costly instruments, nothing of any practical value will be gained. When experimenting last year with several antiseptics to test their value as prophylactics of the plague, I found that quite a number of them if properly used would effectively prevent the development of the disease, even if an infection or an inoculation with potent material had taken place (*cf.* my last report), but at the same time it was also found that some of these were too expensive to come into general use, that others were difficult to procure or subject to adulteration, and that still others, among them particularly iodine, though very effective, were decidedly injurious to the health of the animal if given in sufficiently large doses for the necessary length of time. The only antiseptic free almost entirely from all these objections, and at the same time nearly if not quite equal in its prophylactic effect to every medicine tried, proved to be pure crystallized carbolic acid dissolved by gentle heating, and an addition of about 5 per cent. of water, and then sufficiently diluted with the water for drinking.

I also tested inoculations with cultivated swine plague Schizophytes and found them to be of some prophylactic value, at least in so far that such inoculations, as a rule, produced a comparatively much milder form of disease than that caused by a natural (accidental) infection, and as such a milder attack resulting from an inoculation with cultivated swine plague Schizophytes destroyed, partially at least, the existing predisposition, or protected for the future about just as much as an attack brought on by a natural infection, but no more. The protection, the same as after an attack of swine plague caused by a natural or accidental infection, or by an inoculation with infectious morbid products (lung exudation, for instance), was not always sufficient to entirely prevent a subsequent infection, or some more or less serious reaction after a subsequent inoculation with potent material, but the disorder following or caused by such a subsequent inoculation or infection was never severe. It either did not amount to a fully developed second attack of swine plague, manifesting its presence by plain symptoms resulting from new morbid changes, but was insignificant and in some cases almost imperceptible; but if it did, the second attack was never a severe one and never became fatal. Experiments and inoculations with swine-plague Schizophytes, cultivated in substances foreign to the organism of the hog, are very interesting and of high scientific value; they are well calculated—perhaps better than anything else—to lead to a higher knowledge of the Schizophytes or Microbes, their nature, metamorphoses, manner of propagation, their mode of action, &c., and particularly to throw light upon the conditions which determine the pathogenic properties or the comparative innocence of the swine plague Schizophytes; but they are hardly of any practical value to the farmer.

A cultivation of swine-plague Schizophytes, or of any other pathogenic Microbes, for the purpose of making prophylactic inoculations, requires great care and circumspection, and without a very good microscope would have to be made completely in the dark; consequently it cannot be expected that even one farmer out of a thousand would be able to make such a cultivation without danger of doing more damage than good. Experimenting with cultivations of the infectious agencies of fatal diseases, unless conducted with the greatest care and a thorough understanding of every detail, is a dangerous business, and very apt to result much more in a further spreading of the disease than in its suppression.

All these facts and considerations induced me to concentrate my efforts in another direction and to pursue in my experiments the following plan, based upon the pecularities of the disease, and the results of former observations. It contains two leading points—one consisting in removing the animals from every known source of infection, in stopping and avoiding as much as possible the means by which the disease germs can or may be introduced into the animal organism, and in permitting no more avenues of ingress than are unavoidable; and the other consisting in counteracting the action of the disease germs already introduced into the system, or, more correctly speaking, in employing such means as will, according to experience, prevent their further development and propagation, and destroy, or at least essentially diminish, their pathogenic properties. This plan, whenever fully executed, proved to be very successful, but its execution is not quite as simple as it may seem to be. The disease germs cling to and are protected by a great many things, and, under certain conditions and while in a certain stage of development, possess a great tenacity of life and a wonderful power of propagation. The means and carriers of infection, therefore, are many; and as to the avenues of ingress not only the digestive canal and larger wounds, but also very small insignificant sores and scratches or abrasions, constitute excellent means of introducing the disease germs into the animal organism. One mistake or neglect, therefore, may defeat all our efforts. In the following I will enumerate the essential points which seem to me to demand attention:

MEANS OF PREVENTION.

Some of these measures are self-evident, and it will not be required to give reasons for their efficacy or why they are necessary if it is kept in mind that swine plague is a very infectious disease.

1. Wherever swine plague happens to be prevailing in a neighborhoods no hog or pig must be allowed to run at large, but every herd and every hog should be kept shut up if possible in pens or yards on the premises of the owner. Considering the fact that the swine-plague germs are discharged in immense numbers by the diseased animals with their excrements, &c., and rise into the air as Schizophyte germs, and probably as micrococci, to a limited height, on coming down are deposited with the dew or rain upon the grass, herbage, and into water, it is dangerous in an infected neighborhood to allow healthy swine to be in the pasture while the grass is wet with dew or rain, unless the rain has continued long and been sufficiently heavy to wash away everything that is very minute and light. Hence, when it is desired that a herd of hogs should have the run of a pasture while the disease is in the neighborhood, the time must be limited to between 10 o'clock in the morning and sundown, or to hours during which the grass is dry. The Schizophytes are soon destroyed where sunshine and fresh air have full access, and where at the same time moisture is wanting.

2. Every transportation of diseased and dead hogs is apt to cause a further spreading of the plague, and therefore should be strictly avoided. National, State, and municipal governments quarantine against yellow fever, send small-pox patients to the pest-house, prohibit the importation and transportation of cattle affected with pleuro-pneumonia, order killed dogs suspected of being mad, and laws are in existence in several States which forbid any importation or transit of apparently healthy Texas and Cherokee cattle during certain portions of the year for fear of the spread of Texas fever. Why not have a law that forbids and punishes the transportation of swine affected with or that have died of swine plague --a law that shall compel every one to keep his hogs and pigs on his own premises, especially if the disease is in the neighborhood, say, within a radius of two miles; and also forbid and make it a punishable offense for any one to contaminate or pollute any stream of running water (which does not terminate on his own grounds in a pond or lake without any outlet) by throwing in carcasses of dead hogs or parts of the same, or

by allowing diseased hogs and pigs to have access to such stream? Such a law, if properly framed, could be executed, would harm nobody, and prevent very much the spreading of swine plague.* Especially this present year really malignant cases of swine plague have been comparatively rare, and the disease on the whole of an extraordinarily mild type; severe cases and a rapid spreading could be found only where the hogs were allowed to roam at large and to frequent places which afforded special conditions favorable to the preservation of the swine plague Schizophytes or Microbes.

If it had not been for such places—timbered land, especially such as contains much underbrush and rank vegetation, and is near the border of a creek, and yards, pastures, &c., containing old straw-stacks or accumulations of other similar loose and porous substances—it might have been very difficult or even impossible to find during the year any case of swine plague of a malignant type in the whole State of Illinois. At any rate, where these conditions did not exist no cases could be found, unless it was in a herd in which the origin of the disease could be traced to just such a source.

3. Healthy and non-infected herds of swine, and also those which possibly may have become infected but do not yet exhibit any plain symptoms of disease and can probably be saved, must be kept away from streams of running water accessible to diseased animals above, and in any way polluted or infected with swine plague either through the excrements, excretions and secretions of the sick hogs, or by the carcass of a dead hog. But as this point has been dwelt upon at some length in my former reports, a mere mention of it will suffice.

Where swine plague is in the neighborhood hogs should also be kept away from pools of stagnant water. Stagnant water, especially in a small pool, is very apt to become a receptacle of a great many disease germs, and as it always contains more or less organic matter it is also well adapted to their preservation and propagation and constitutes a good means of infection.

4. One of the sources that contributes more than anything else in perpetuating swine plague on a farm—always affording a ready means of infection—is a straw-stack in a hog-yard or in a swine pasture, especially if the disease is in the neighborhood. The danger is the greater, it seems, the older and larger, and the more undermined the straw-stack. Being a porous body, a poor conductor of heat and well calculated to retain moisture, it not only affords a good receptacle but also an admirable protection for the swine-plague Schizophytes, well calculated, as has been shown in one of my former reports, to preserve the same for a whole year. That such is the case has found recent confirmation.

A hay-stack is probably just as dangerous, but a farmer very seldom places a hay-stack in a hog-yard, and, besides, the hay is usually needed for feeding, and the stack therefore is removed before spring. A great many Western farmers put a straw-stack in the hog-yard for two or three

* Some time during the winter of 1880 and 1881 J. Chrisman, of Gage County, Nebraska, found that his hogs were dying off with some disease that he could not control, and to secure himself he advertised his stock for sale. His neighbors bought what hogs they wanted, not knowing of any disease among them. After they took them (the purchased hogs) home, they found, when it was too late, that they had the swine plague. Some of the buyers of Chrisman's hogs lost almost all, not only those they bought but those they had on their farms. Mr. Frank Pethoud informs me that his loss exceeded $1,000. Mr. Frank Jones lost very heavily, also Mr. David Littlejohn. As this was the first time that swine plague was ever known in Gage County, people were unprepared and ignorant of the proper way to treat it. I do not know where Chrisman bought his hogs, but I think they were bought of a mover who was coming West. (Extract from letter from Samuel E. Rigg, druggist, Beatrice, Gage County, Nebraska.)

reasons; first, to have it out of the way, as they often do not know what else to do with it; secondly, to let the hogs pick up the grain which the thresher may have left in the straw; and, thirdly, to have inexpensive shelter for their hogs which will soon burrow holes into it and make themselves a warm lair. In cold and inclement weather, and also in a hot summer (July and August especially), hogs need shelter, but this should not consist of a straw-stack, and should be made of other more compact or less porous material. At any rate, in a country where the plague is prevailing, a straw-stack has no business in a hog-yard or swine pasture. Even farther west, where lumber is expensive, a hog-shed of lumber, with a roof above, a floor beneath, and divided into several compartments, does not need to cost very much, and if well made and built upon a stone foundation will last and be serviceable for many years and afford all the protection required.

5. The next point deserving attention as a means of prevention is cleanliness. Even if swine plague does not prevail within a hundred miles it pays to keep the troughs, pens, yards, &c., clean and free from accumulations of manure, old bedding, corn-cobs, and dirt in general, because no animal is more thankful for cleanliness and rewards it better by increased growth and thrift than a hog, notwithstanding its name is suggestive of the contrary. A hog, if not more, is at any rate fully as sensitive to the sanitary conditions of its surroundings as any other animal, a fact often lost sight of because a hog is an omnivorous animal, roots in the ground, and is fond of cooling its body by taking a bath wherever water is convenient, even if its purity is questionable. Dirty or muddy water cools as much as clean water, and cooling is what the hog desires.

6. Another point of great importance consists in avoiding any operation whatever that draws blood if the disease is in the neighborhood, because every sore, wound, scratch, or mere abrasion constitutes a port of entry for the disease germs and seems to attract them. The operations of castrating and ringing, spaying, slitting the ears, cutting off a a piece of the tail, &c., should be avoided. If for some reason or other it becomes necessary to castrate a precocious pig while swine plague is prevailing, it is advisable to dress or wash the wound with some antiseptic, diluted carbolic acid for instance, not only as soon as the operation is finished but also the next day and the day following, and to keep the animal separated from the herd till a healing has been effected. Ringing is altogether inadmissible and out of the question, as long as any cases of swine plague are near. Accidental wounds should receive antiseptic treatment—be dressed with carbolic acid. That all kinds of wounds are exceedingly dangerous in so far as they attract the disease germs has already been shown in my former reports, and all I have to add is that more recent observations have given ample confirmation. Introduced through a sore, wound, scratch, or abrasion it requires much less of the infectious principle to start and to produce the morbid process of swine plague than it does if introduced through the intestinal canal.

7. There are yet several other points of more or less importance which deserve attention, but as some of them are self-evident and others have been fully discussed in my former reports a brief mention will probably suffice. It is self-evident that no diseased hog or pig can be allowed to mix with healthy swine or to enter the premises or places occupied or frequented by a healthy herd of hogs; it is also equally self-evident that the latter should be kept away not only from diseased hogs but from places and things which there is reason to suppose have become infected. Fur-

ther, men in their clothing, and animals probably in their fur or coat of hair, and perhaps with the dirt that may happen to stick to their feet, are able to convey the disease germs from one place to another; consequently men and animals (dogs particularly) which have been in contact with diseased or dead hogs should not be allowed to enter the pens, yards, pastures, or premises occupied by healthy swine. Neither should straw and hay, for bedding, nor food of any kind which comes from an infected place, be used for healthy hogs. Even rats coming from infected premises are probably able to convey the swine-plague germs and to communicate the disease to healthy animals; but to guard against an intrusion of that kind may often be a difficult matter. Other carnivorous animals, after having feasted on a dead hog—fortunately but a few of them will touch the carcass of a hog that has died of swine plague—in some instances may also effect a communication of the disease.

The points just enumerated are all very essential and even indispensable to a successful prevention not only of an invasion of swine plague, if that disease is in the neighborhood and the herd to be protected is yet free, but also of a further spreading of the disease and of an increase in its malignancy after a portion of the herd has become infected or diseased. In such cases, if anything at all is to be accomplished by a use of prophylactics, it is of the utmost importance to employ all means possible, and to neglect nothing by which a further influx of disease germs can be prevented. If the latter is not checked, but permitted to be constantly increasing, the best prophylactic treatment will be of very little avail.

The following measures of prevention are of a more special character, and apply principally where an infection has taken place, and where cases of swine plague are already occurring within the herd:

8. A measure of the greatest importance consists in *a strict separation of all animals apparently healthy from those already showing plain symptoms of swine plague, and the removal of the former to another place which is not infected.* Its object is to stop and to prevent as much as possible a further influx of swine-plague germs or pathogenic Schizophytes. Whenever the plague has made its appearance in a herd of swine, the herd usually can be divided into three portions or sections—the first to be composed of those animals which do not show any symptoms of disease whatever and are apparently healthy, the second to comprise all those animals which show slight but still somewhat doubtful indications of sickness, and the third to consist of all those animals which are evidently sick. If the herd is a large one, and many animals have already shown evidences of disease, it may often be advisable to subdivide the third section into animals not very seriously affected and giving hope of recovery, and such as are already in an advanced stage of swine plague and almost sure to die. As the latter are of very little value, if of any value at all—because most of them will die, and the few which possibly may survive will never be of any account or pay for the food they consume—it is, as a rule, in the interest of the owner to kill every one of them at once, and to bury or to cremate them as soon as dead. By so doing an immense amount of disease germs will be destroyed, much danger of further infection and of increasing malignancy will be removed, and a great many animals not yet infected may thereby escape, or if infected may thereby get off with a mild attack. But it is very seldom that the average farmer can be persuaded to dispose in that way of a live animal. He says: "As long as there is life there is hope," no matter whether the hope is worth anything or not. Therefore, if the owner does not want to kill the hopelessly diseased hogs, he may leave

them at the already badly-infected place where they are, and not move them at all, as that would only still more infect the premises—spread the infection over a larger area.

The first section, comprising such animals as are apparently healthy, should be selected with care by assigning every animal in the least doubtful to section No. 2. It should be taken to another piece of inclosed ground, or non-infected yard, which is high and dry, destitute of stagnant and running water, of straw-stacks, half-rotten manure, mud-puddles, &c., and does not under any circumstances receive any drainage from the infected hog lot or from other infected places. If the piece of ground is bare, that is, destitute of all vegetation, so much the better; if it is not, plowing can make it so. Section or lot No. 2, containing all animals which do not show plain symptoms of disease, should also at once be removed to a similar place as section No. 1, which may adjoin it, but the pen or yard occupied by section No. 1 should be higher, or at least not receive drainage from the pen or yard occupied by section No. 2. The reasons for this provision, I think, do not need any explanation. If section No. 3, composed of the really sick animals, is subdivided, the subdivision comprising the less-affected animals, or those which possibly may yet recover, or are worth saving, should likewise be removed to a similar place as section No. 1 and section No. 2, but it should be a place which does not send any drainage to the yards occupied by sections Nos. 1 and 2 and does not receive any from the old hog lot or from other infected places.

All this, however, is not enough. The separation must extend also to the water for drinking, to the food, and to the attendance. The animals in each pen or yard should have one or more troughs for their exclusive use, which should be placed in the lowest corner of the yard, so that when they are emptied or upset to be cleaned the water will at once flow out of the pen or yard, and not form a mud-puddle, hog-wallow, or pool of stagnant water. As to attendance, if the herd is a large one and the owner has hands enough, it would be best to give to every section a separate attendant, with strict orders not to meddle under any circumstances with any of the other sections, or to enter the other yards. If that cannot be done, and but one man has to care for and feed all the hogs, sick and well, it must be made an invariable rule to always attend first to section No. 1, then to section No. 2, then to subdivision of section No. 3, and last, to the very sick animals. This order must under no circumstances be reversed, and the attendant, after he has been to to the sick animals, must not again approach those in a healthy condition until the next feeding time, or has first been disinfected by attending to other outdoor work. If all these precautions are taken and conscientiously carried out, a board fence tight enough to prevent a pig from putting his head through and stealing food or water from the adjoining pen or yard, is sufficient separation, because swine plague is very seldom, if ever, communicated through the respiratory passages, unless the lining mucous membrane is sore, scratched, or wounded, or has abrasions. In such cases the mucous membrane attracts and absorbs the disease germs just as readily as a sore, wound, &c., in the skin. To perfectly healthy lungs and respiratory passages an inhalation of infected air seems to be harmless, but where the air is badly infected, food and water exposed to the air are very apt to also become infected. Hence, wherever healthy and diseased hogs are kept under the same roof and in the same building, though in strictly separate pens, thorough ventilation is not only advisable but also necessary. If the observation of others have led to the conclusion that swine plague can be communicated through the respiratory organs, all I have to say is, that if they had made a close examination they undoubtedly would have found in every case in which apparently an infection through the respiratory organs took place some lesion or lesions of the mucous membrane of the respiratory passages. As the very smallest and most insignificant lesion attracts and absorbs the disease germs, the loosened, congested, and swelled condition of the respiratory mucous membrane and a partial divestiture of its protection, its epithelium, affected by the presence of lung worms (*Strongylus paradoxus*), are as sufficient in absorbing the disease germs as a sore or abrasion.

If a strict separation is effected and maintained, neither man nor beast, coming in contact with diseased animals or entering the yards or pens occupied by diseased hogs, must be allowed to enter any of the pens or yards of animals yet healthy. The latter themselves need close watching, to see whether any of them show symptoms of disease, because it must be supposed, till the contrary is proven, that nearly every animal belonging to an infected herd, although not yet showing any symptoms, is more or less affected. If an animal in section No. 1 appears doubtful, or shows the least symptoms of not being well, it should be at once transferred to section No. 2; and if an animal belonging to the latter commences to exhibit plain symptoms of swine plague, it should without delay be removed to section No. 3, because every diseased animal discharges with its excrements, urine, and other excretions and secretions a large amount of pathogenic Schizophytes or disease germs, thus increasing the means and consequently the danger of further infection.

9. All animals that die of swine plague must immediately, or at any rate as soon as possible, be buried or cremated. Their carcasses contain a vast and rapidly increasing amount of pathogenic Schizophytes, and if left on the ground, or not destroyed by fire, these Schizophytes will become disseminated over the premises, and are apt to be taken up by other animals; but if the dead hogs are promptly buried, or, still better, cremated, all these germs are destroyed and out of the way. That it will not do any good to scratch a hole in the ground and to cover the carcasses with just enough earth to bury them out of sight, as is so often done, is self-evident. Every hog that dies of the plague, unless cremated, should be covered with at least four feet of earth. Some farmers, in order to get rid of their dead hogs, throw them into ravines, into creeks, streams of running water, and ponds, or allow them to rot by the roadside, and others let them lie where they have died till the tankman comes and hauls them off. All this promotes a spreading of the disease, and should not only be prohibited but should be severely punished by law.

10. As to food, it is immaterial whether it be mostly corn or something else, if it be wholesome, clean, and not in any way contaminated with the disease germs of swine plague. If there is any doubt as to its contamination it should be subjected to cooking or steaming before it is fed, because cooking and steaming will destroy the disease germs and thus act as a disinfectant. But after the food has been cooked or steamed it will not do to expose it to a badly-infected atmosphere, for if so exposed it will attract the disease germs and again become dangerous. It should be fed as soon as convenient, or as soon as sufficiently cool. If some animal food can be given it cannot be objected to, unless it is of a dead hog, because it seems, if animal food is given, the pathogenic Schizophytes which may happen to enter the animal organism through the

digestive canal are very often, but not always, either digested, pass off with their excrements, or lose their pathogenic character.

As for the water for drinking, it should be drawn fresh from a well each time the animals are watered, and should not be allowed to remain stagnant in the troughs any longer than from one meal to another. That running water, accessible above to diseased animals, and stagnant water from ponds, &c., are very dangerous if swine plague is in the neighborhood, has already been stated. If skimmed milk, slop, or swill is given instead of water, the only precautions necessary are not to give any more at a time than will be consumed and to keep the troughs clean.

11. *Prophylactic medicines.*—There are several which, as to their prophylatic properties, do not present much difference. Otherwise, however, the differences are great. Iodine in a watery solution—ten grains of iodine and twelve grains of iodide of potassium dissolved in an ounce of water—given in small doses is very effective, and, as the dose is so small, is not expensive either, but it does not agree with the hogs. It causes them to lose their appetite, affects all secretions and excretions, and seriously interferes, at least during the treatment, with the growth and development of the animal, which soon becomes more or less emaciated. Besides, the pigs do not like it, and would rather go thirsty than take their iodized water, which is a very serious objection, especially if an animal is already affected and does not care much for food and drink. Hyposulphite of soda, which was tried quite extensively some time ago, produced satisfactory results as a prophylactic, but if used in sufficiently large doses, and for such a length of time as is necessary, it caused diarrhea, and thus weakened the animal. If bought at wholesale in large quantities it is not expensive. Benzoate of soda seems to be effective, but causes diarrhea, and is too expensive, therefore out of the question. Salicylic acid is expensive, and far inferior in its effect to carbolic acid. Thymol, or thymic acid, where used, gave satisfactory results, provided the preparation was genuine. It is a high-priced article, and therefore frequently subject to adulteration. Still, if a genuine and really superior article could everywhere be procured, its high price would be no serious objection, because the dose required is very small. But it is not as easily handled and dissolved as, for instance, carbolic acid.

Of all the antiseptics experimented with as prophylactics, carbolic acid, everything considered, has given by far the most satisfactory results. Considering the small dose, 8 to 10 drops of a 95-per-cent. solution three times a day for every hundred pounds of live weight, it is very inexpensive, as a pound goes a good ways, and a pound of Mallinckroodt's best crystallized carbolic acid, such as I have almost exclusively used in my experiments, can now be bought, if purchased in large quantities, for 65 cents. Retail druggists usually ask from 75 cents to $1. It is not disagreeable to the hogs; does not destroy their appetite or perceptibly interfere with any organic functions, except that it reduces the animal heat, which, perhaps, is just what makes it an efficient prophylactic. Of course, if much larger doses than those indicated are given, which is not at all necessary, it becomes a deadly poison. After it has been used a few days the animals evidently like it, and seem to almost crave for it when its use is discontinued. Even the diseased animals, long after they have ceased to care for solid food, will take the carbolized water. It is, however, only a prophylactic, and all it does or can be expected to do is to destroy the conditions necessary to the development and propagation of the swine-plague Schizophytes. It does not directly kill them, at least not in such a dilution in which it can be safely given to a hog; its effect, therefore, it must be concluded, is either indirect (probably) or accumulative. It will not and cannot repair or even reduce the morbid changes which have already been produced and are still existing, and therefore cannot be expected to effect a cure of a diseased animal. Such a thing is out of the question. All that carbolic acid or any other prophylactic can be expected to do is to prevent and to arrest the morbid process by changing or destroying certain conditions necessary to the metamorphoses and propagation of the pathogenic Schizophytes. So, for instance, iodine, it seems, is an efficient prophylactic principally on account of its great affinity for albuminous compounds, the very thing that is appropriated and withdrawn from the organism of the animal by the Schizophytes; iodine, therefore, deprives the latter of their pabulum, and thus destroys the conditions necessary to their development and propagation.

If a cessation of the morbid process has been effected by arresting or neutralizing its cause, and the morbid changes produced are not already irreparable, a "cure"—that is, to effect recovery—may safely be left to nature. If the morbid changes have become irreparable the animal will in all probability die; if it lives it will only partially recover, and never be healthy again.

In conclusion, it may be well to say a few words about the manner of administering medicines to hogs. If one commences it right it is very easy; but if the nature of the hog is not understood, and force is attempted, not much success will be attained. A hog has a very fine nose, but rather indifferent taste, and therefore will voluntarily take almost anything, even quinine, if it is mixed with its food, provided it has not an objectionable smell. This, however, does not mean that things which have an objectionable smell to human beings have the same to hogs; on the contrary, a hog undoubtedly finds certain things very pleasing to its olfactory nerves, and, maybe, highly aromatic, which are nauseating to a human being; and *vice versa*. There are, therefore, a great many medicines which are voluntarily taken by any hog if mixed with its food or drink, and to give the medicines with either food or drink is by far the best way, as long as the hog has any appetite or any desire to drink. Fluid medicines are best administered in the water, milk, or slop, and so are soluble powders or powders of light specific weight, light enough to swim in water. Heavier and more or less insoluble powders, such as calomel, cannot in that way be given, but must be mixed with the food—a mash, for instance. If the hog has but little appetite, and is therefore not inclined to take the medicated food, a boiled potato, or a piece of one, constitutes the best vehicle for the medicine, because the hog will take it if it has any appetite whatever. Of course, all solid medicines designed for hogs, especially for such as have diminished appetite, must be concentrated and be of small bulk. Voluminous medicines won't do. If a sick hog has no appetite whatever, or will not take even a boiled potato, and it is necessary to give some medicine, it must be administered either in shape of small pills or by means of a hypodermic injection, and of course be concentrated, or of very little bulk. To drench a hog is a dangerous and difficult operation. The animal, as soon as force is used, will squeal, and then, when taking breath, the medicine will go down the windpipe into the lungs, and often suffocates and kills the animal before the whole drench is poured down, or if not killed outright it usually dies within a short time of inflammation of the lungs and respiratory passages. Drenching a hog is doubly dangerous, if the drench contains undissolved or suspended powders. Any one familiar with the anatomy of the larynx and pharynx of the hog will know the reason why drenching is attended with so much danger. Those who prescribe medicines to be administered as a drench manifest by so doing their gross ignorance, and proclaim themselves as inexperienced quacks.

TREATMENT OF VERY SICK ANIMALS.

As to a medical treatment of an animal in an advanced stage of swine plague I have no suggestions to offer, as I have long ago come to the conclusion the sooner such an animal dies, or is put out of the way, the better it is for the owner, at least as far as dollars and cents are concerned. I advise those who yet believe in the possibility of curing (restoring to health) a hog in an advanced stage of the plague to make a few *post-mortem* examinations, to examine particularly the lungs, the lymphatic glands, the heart and intestines, and then compare what they found with the condition of those parts or organs in a healthy animal, and they will soon be converted.

Very respectfully submitted.

H. J. DETMERS.

CHAMPAIGN, ILL., *October* 30, 1881.

CONTAGIOUS PLEURO-PNEUMONIA.

FINAL REPORT OF CHARLES P. LYMAN, F. R. C. V. S.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: In compliance with your instructions I have the honor to report the following:

In Maryland during the last two months contagious pleuro-pneumonia is reported to me as having received some further extension; nothing, however, in this connection is especially important, for the diseased district remains practically the same in this State. For some reason or other the proprietors of the bone-boiling establishment have reduced their price for dead and dying cows to $2 per head. This the owners of such animals consider too small a price, and as a result the carcasses become the property of the "pudding butchers," and so, I suppose, much of this meat becomes human food, for which purpose it is, to say the least, worthless. Cattle are killed in and about Baltimore by butchers in their own establishments, and, I am informed, none of them kill in excess of twelve or fourteen head a week. It seems to me that the local board of health could do much to prevent this rather disgusting state of affairs, by the establishment of abattoirs and compelling all butchers to come into them, as is done in Boston, and to a certain extent in Philadelphia and New York. Your inspector for Maryland says that he is satisfied that now most of the diseased animals are kept away from the stock yards in and about Baltimore. He says:

> The greater danger lies in the sale of animals that have been hurried into market from farms or stables where "contagious pleuro-pneumonia" has made its first appearance. Members of agricultural societies could prohibit this practice to a great extent if they would notify the man in charge of the stock yard of such transactions; it would destroy the sale of such stock.

Very few cattle are being shipped now from Baltimore to Great Britain.

In Pennsylvania, contagious pleuro-pneumonia has received a fresh outbreak; this time in York County. Three additional herds have been infected, two in Springfield and one in Shrewsbury. This naturally extends the more recently infected district; but the whole matter is in the efficient hands of Mr. Secretary Edge. The infection has been traced in one case to Harford County, Maryland, and in the other two to Baltimore.

Your inspector for Pennsylvania says:

I am quite satisfied the butchers get most of the cases of contagious pleuro-pneumonia now, as the farmers know too much to keep their infected animals alive, and this must help rid the country of the disease.

There were shipped from Philadelphia to Europe, in 1878, 4,156 head of horned cattle; in 1879, 5,876 head; in 1880, 2,474; in 1881, none.

This is a sample of the way or the rate at which this whole trade is being lost to us. A letter on this subject from Messrs. Peter Wright and Sons, of Philadelphia, says:

During the latter part of 1878 we had contracted with prominent shippers of Chicago and Philadelphia (whose names we can probably get permission to give if you desire it), for shipment of, say, 300 cattle per week, from Philadelphia to Liverpool, and about the same number from Baltimore to Liverpool, and, in order to fulfill these contracts we dispatched a representative to Europe to arrange with prominent ship-owners there for regular weekly lines of steamers (seven steamers in each line) to run between the above-mentioned ports, during the shipping season of 1879. Upon the passage of the order in council, in February, 1879, our shippers were unable to fulfill their contracts, and we were placed in the most embarrassing position with the owners of the steamers which we had secured, and had to face the probability of very heavy loss.

The total expense incurred in the suppression of pleuro-pneumonia in the State of Pennsylvania by the State authorities during the year 1881 has been $3,409.62.

And had it not been for Maryland allowing diseased cattle to be sent out of their State, we should now be clear of this disease (that is, if there is no more disease than we know of now in this State.) I think there is no doubt that this State will continue its present organization for the suppression of contagious pleuro-pneumonia, even should the expense exceed $5,000 per year, for a year or two at least, without any money help from Congress, *as our owners of stock thoroughly understand the danger of the disease.*

Cattle killed on account of being diseased are now cremated by order of the State authorities.

From New Jersey I have no advice relating to the extension or diminution of contagious pleuro-pneumonia. Facts relating to this matter can only be obtained now from Dr. E. M. Hunt, upon whom I had no authority to call for the information. Your inspector located at Camden writes as follows:

On the 7th December I detected two cows with lung trouble, in two lots of five and six, respectively, which came to the ferry yards from Mount Holly, Burlington County, New Jersey. The other from Elmer, Salem County, consigned to the same firm and intended for "Bologna" beef. I accompanied them to the slaughter-house, where I had to remain nearly the whole day in order to see them slaughtered, which was finally consummated. The Mount Holly cow was an old chronic case, having a large abscess in the central portion of the right lung, together with a cavity in an adjoining portion. The left lung also had a small cavity in the inferior portion of the larger lobe. The Elmer cow was an acute case, affected in one lung, which was already beginning to take on a condition of hepatization.

On the 9th of the same month I detected a two-year-old steer in a lot of twenty-one head brought on the river. The steer was said to have been brought from Baltimore, Md., which I found to be true, as I traced him directly back as far as Wilmington, and then ascertained that he had come thence from Baltimore.

On the 13th I found three chronic cases in another lot of "Bologna" beef cows coming here from Gloucester County, New Jersey. On the 17th another chronic case from Camden County; on the 22d two other chronic cases from Gloucester County, and on the 27th a subacute case from Burlington County. All of them, with the exception of the steer, were cows intended for slaughter for "Bologna beef," were in good condition apparently—some of them fat—and were, with one or two exceptions, entirely recovered from the effects of the disease as far as one could judge by external appearances, and were all en route from New Jersey to Philadelphia for slaughter.

The State of New York has, I understand, some $50,000 in treasury appropriated for stamping out pleuro-pneumonia. Of this amount they are said to have used only about $3,000, and it seems to be a fact that the disease has, during the past year, received quite important extension within the limits of the State; that is, it seems to have reoccupied the portions of the State about New York City which were so thoroughly purged by Professor Law but a short time since.

I do not know that I can add much to this report that will increase its value; the facts speak for themselves. Although I think that most decidedly England has never received a case of pleuro-pneumonia from either Boston or Portland, I still think that their position upon the question of their receipt of our cattle is a perfectly fair one, and leaves no room for complaint. When it is remembered how many thousands pounds sterling have been lost by British cattle owners on account of the introduction among their herds of foreign cattle affected with exotic contagious diseases, and, as they say, when one thinks of how little provision we, as a government, have made to prevent the spread of pleuro-pneumonia, it is difficult to see how they can do otherwise. That this disease really has an existence in a certain part of this country, they, through their consuls, are as well aware as we, and no amount of testimony to the contrary by this intelligent farmer and the other experienced dealer, will have the slightest possible effect upon their action. I thoroughly believe that were we able to show a country entirely free from this disease, the restrictions now imposed upon our cattle landing in Great Britain would at once be removed, other conditions being the same as now. That is, I am a strong believer in their honesty of purpose in this matter. It is a significant fact that no condemnations have been made since last June upon cattle coming from Boston or Portland.

In regard to ridding ourselves of this present incubus upon what should be a large and profitable export trade, and which now seems threatened with extinction, as well as to prevent for all time the great danger, which I feel to be a real one, of the introduction of this pest to our Western cattle ranges, from whence it could never be dislodged, I can think of but one method which seems to me to offer in any degree a hope of success, and that is for Congress to take the matter in charge in some way that will give the power to and compel some *one* authority to control the movements of all animals within the diseased districts, and at the same time take such other steps as may be necessary for the killing of all animals diseased or infected. I have no faith in the unanimity of action in the matter by the directly interested States themselves—this for various reasons, which I have thoroughly learned to appreciate during my recent experience—neither will action, which only creates a power capable of spasmodic effort, be of avail, else the whole country will but repeat the recent experience of the State of New York—a number of thousands of dollars spent for nothing and a full supply of pleuro-pneumonia on hand.

Therefore, unless national action can be had, and that in such a way and under such circumstances as to insure the continuance of proper measures until the desired freedom from the disease is attained, it would be just as well, as far as the effect upon contagious pleuro-pneumonia is concerned, to let the matter alone first as last, and certainly to do so at first would contribute very largely to the comfort of any one who might be appointed executive of any compromising methods of extermination; that is, if it is not a "bull" to assume that one can stop doing a thing before he commences it. I think I have heard somewhere of its being better for a man, under certain circumstances, if he had never been born.

I cannot close this letter, which I suppose will be my last one to you, without thanking you for your numerous kindnesses to me, and wishing you personal prosperity in the administration of the many and varied duties of Commissioner of Agriculture. If at any time such information regarding contagious pleuro-pneumonia as I may have will be of service to you, I shall most gladly furnish it.

Respectfully submitted.

CHARLES P. LYMAN.

BOSTON, MASS., *January* 30, 1882.

DISEASES AMONG HORSES IN ILLINOIS.

Hon. GEO. B. LORING,
Commissioner of Agriculture:

SIR: When I received your dispatch of the 8th instant, directing me, at the request of Hon. James R. Scott, president Illinois State Board of Agriculture, to inquire into a fatal epizootic among horses in this (Champaign) county, I had already, on the 6th instant, made a visit to the locality where the alleged epizootic prevailed, a farm near Linden-grove in the northeast corner of Crittenden Township, about 18 miles southeast of Champaign. One mule about ten years old and three young horses (two mares and one gelding), each about three and one-half years old, had died, and one mule about ten or eleven years old was diseased, while one 8-year old horse was yet, to all appearances, perfectly healthy. All six animals were owned by Mr. Wm. Silver, and constituted the whole stock of horses and mules kept on his farm. According to Mr. Silver, the animals which died exhibited the same symptoms as the mule, which I found diseased. The latter, a mare mule, was almost completely paralyzed, and found lying prostrate on the ground about two rods from a small ditch in a field or pasture and not far from the house. All the voluntary muscles appeared to be flaccid; every limb could be placed in any position desired; the ears were hanging downward and backward, following the law of gravity; the tail when placed in an unnatural position could not be removed out of it into a more natural one, although the animal at the same time was able to make, and did make, feeble kicking movements with all four legs. The urine incessantly flowed off from the vulva probably in the same quantity in which it was secreted, and presented a normal color but a somewhat ropy appearance. The rectum was full of dung, which was not voided till it was crowded out by other fecal masses. If pricked with a pin in the hind quarters the animal did not react at all, and if pricked further forward it only showed slight sensitiveness, indicated by a barely perceptible quivering of the skin, which did not amount to any defensive movement. Paralysis was therefore considered as almost complete. The pulse was very small and feeble; only 44 beats in a minute could be counted; and the temperature in the rectum and in the vagina was low—a few degrees below normal. The thermometer I had with me, and which I was compelled to use, as the one in regular use met with an accident a short time before, was not very accurate, and only indicated 97°F. The temperature was probably 1° higher. The animal made faint, though almost incessant, struggles with her legs—kicking or pawing motions—just such as a horse or mule almost entirely deprived, like the one in question, of the control of its limbs very likely would make if suffering from colic or from some internal pain of a spasmodic nature. As my first visit happened to be in the evening, a little after sunset, and as the struggles of the animal, by bumping her head on the ground, had caused the eyelids to swell to such an extent as to nearly close the eyes, an abnormal dilation of the pupils, if existing, could not be observed. The color of the visible mucous membranes, wherever the latter were not lesioned, and therefore more or less inflamed, appeared to be normal. My first diagnosis, very naturally, was cerebro-spinal meningitis, notwithstanding some of the symptoms usually attending that disease were wanting.

Your dispatch was received at 5 p. m., November 8, and my second visit was made the next day, November 9. I found the sick mule still alive, and even somewhat better, for she was able to move her ears, to keep her head raised, at least for a short time after she had been assisted in raising it, and also to retain her urine. Her appetite apparently was good, pulse and temperature about the same as on my first visit; and the kicking and pawing motions were less frequent or almost entirely absent. The eyes were almost entirely closed by the swelling of the very sore eyelids, but as far as could be ascertained the pupils of the eyes were not abnormally enlarged.

Of the three horses and one mule which had died, the mule was taken sick—became paralyzed—on October 27, and died within 24 hours. According to Mr. Silver, the paralysis was a complete one, and the animal (a mare mule) was observed for two days before that date to be acting unusually dull or drowsy, and to be slow in her movements.

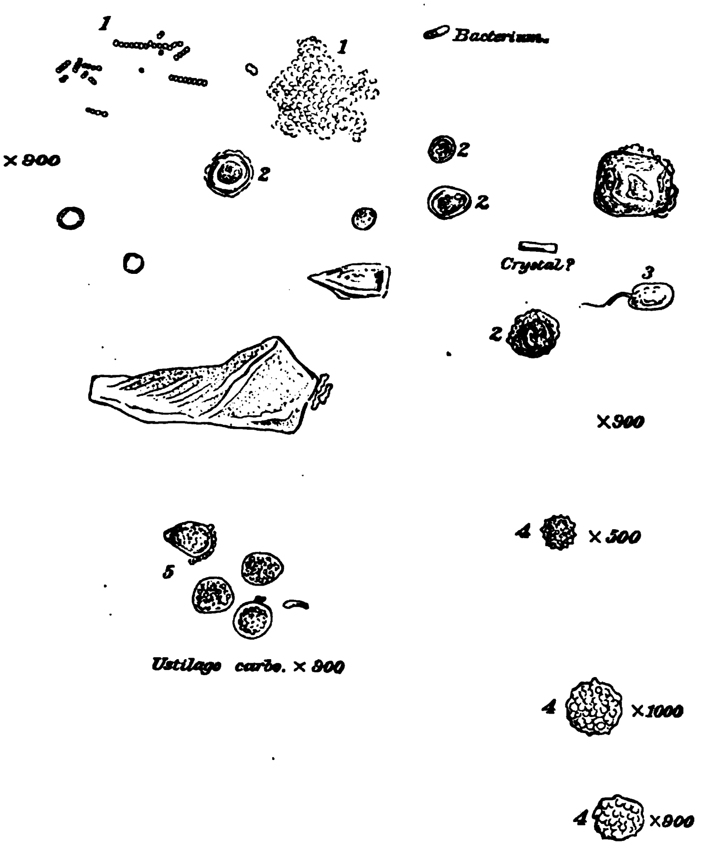
One of the three-year old horses—the gelding—was taken sick on October 28, or one day later than the mule; and the other two—the mares—on October 29. All three died on Sunday, October 30. All of them, as is now remembered, but scarcely noticed by Mr. Silver at the time, exhibited some premonitory symptoms for a few days before they became paralyzed; they appeared to lack their usual liveliness, acted somewhat dull and sluggish, were slow and awkward in their movements, and particularly one of the mares, said to have been a very spirited animal, was lagging behind when hitched to a wagon two days before she became prostrate, and could "bear the whip," which she never could before. None of them, I was informed, showed any signs of bloating or plain symptoms of colic; but as to the latter I have reason to believe Mr. Silver was mistaken, because the almost incessant attempt at struggling and kicking observed in the mule, which I saw alive, cannot very well be interpreted as anything but a sign of distress—symptoms of colic. It may be the other animals struggled less, because in them the paralysis was more complete. Two of the animals that died, it seems, must have exhibited difficulty of breathing—stertorious breathing, probably—because Mr. Silver's brother, Mr. Wallace Silver, an experienced farmer, who saw them while alive, diagnosed inflammation of the lungs. Mr. William Silver made a *post-mortem* examination of the mule which died first, and of the gelding which died October 30. (The two mares died at his brother's place.) In the mule he found the lungs gorged with dark-colored blood, and nothing else abnormal. Brain and spinal chord were not examined. In the three-year old gelding he found nothing that he thought appeared to be abnormal. Brain and spinal chord were not examined. The two three-year old mares, which were taken sick October 29, or very likely during the night of October 28–29, were driven to a wagon on October 28 by Mr. Silver's son to his uncle's place, a distance of about 11 miles, and while there were taken sick and died. The mule, which I found prostrate on November 6, and also saw on November 9, became paralyzed on Thursday, November 3, exhibited premonitory symptoms, dullness or drousiness, for about a week before, was almost completely paralyzed on November 6, a little improved on November 9, and died in the afternoon of November 11, according to a telegram received from Mr. Silver on the evening of that day. I would have gone there again to make a *post-mortem* examination, but the almost continuous rains, heavy on November 11 and November 12, had made the roads so bad that no livery-stable owner in Champaign was willing to furnish me a team to go 18 miles. The mule, while paralyzed, was treated with strychnine (strychn. nitric), of which first one and then two grain doses were given on Monday, Tuesday, Wednesday, and probably Thursday and Friday, with apparently some success in the beginning, or at any rate till Wednesday or Thursday. The mule probably would have recovered, or at least would not have died, if it had not been lying outdoors on wet ground, without any shelter or protection against the cold winds and heavy rains. It rained several days during the week, particularly Tuesday and Friday. Only on Wednesday, November 9, the weather was good. As already stated, my diagnosis, before I subjected the locality, the pasture, the previous treatment of the animals, &c., to a searching examination, was *cerebro-spinal meningitis*, and the same afterwards suffered but a slight modification in so far as the locality, the peculiarities of the pasture, and the conditions and the general treatment to which the animals had been subjected afforded sufficient cause to produce the fatal disease.

The pasture is a piece of rolling land, sloping toward the middle and toward the south; it is divided into two unequal halves by a small ditch traversing it obliquely from northeast to southwest. It is what may be called a new pasture, contains some timothy grass and clover, an abundance of green rye, and innumerable weeds. The northeast portion of the pasture, about two acres of ground, is sloping toward the south, and full of Jamestown weeds (*Datura stramonium*). It was formerly a house place. The Jamestown weeds were mowed in the latter part of June, or in the fore part of July, and left on the ground to wither. Last summer was exceedingly droughty, and the whole pasture, in consequence, became almost destitute of vegetation, except of such weeds, so-called rag-weed (*Ambrosia artemisiæfolia*), for instance, as will grow in spite of any drought. When it commenced to rain in the latter part of September all vegetation revived, an abundance of young rye sprouted, some clover and timothy grass appeared, and young *Datura stramonium* plants became very numerous, even thick. The western portion of the pasture is also higher ground, drained by and sloping towards the small ditch, and contains the rotten remnants of two oat-stacks of last year which were never threshed, because the oats, being very rusty, were not considered worth threshing. These two oat-stacks, at present mere manure heaps, constituted, I was informed, during the whole summer the principal food of the horses and mules, and also of some cattle and hogs kept in the same pasture. Further, near the ditch, close to the southern fence of the pasture, is an old well, which formerly furnished the animals with water for drinking. In consequence of the long-continued drought this well gave out and became dry. Mr. Silver, in order to have water for his stock, recently dug another well three or four steps from the ditch and a few rods north of the old one. This new well, which was dug in the middle or fore part of October, is only 9 feet deep, and contained, when I was there, about 7 feet of water. At any rate the surface of the latter was not over 2 feet lower than the surface of the ground. The water, which is the same as that in the ditch, and consequently surface water, has been critically examined under the microscope by myself, and been subjected to a chemical examination by Prof. H. A. Weber, Ph. D., of the Illinois Industrial University. It has a somewhat peculiar smell, and a rather strange taste, which I am unable to describe. The microscope revealed a good deal of organic matter, principally consisting of vests of vegetable substances, numerous dead and some living monads, very minute micrococci and micrococcus chains, comparatively few larger bacteria, some small, oblong, or almost cylindrical crystals (the latter after some of the water on the slide had evaporated), and some spores similar if not identical in appearance to those of *Ustilago maidis* (*cf.* drawing.) The chemical examination has not revealed any narcotic alkaloid, but has shown that the water contains a considerable quantity of some vegetable extract.

Although well knowing that domestic animals, of their own volition, rarely ever touch *Datura stramonium*, certain symptoms of the paralyzed animals, combined with the peculiar circumstances, the want of almost anything green but weeds till October, the rotten oats diet, and the thereby possibly vitiated appetite of the horses and mules, suggested the possibility that they might have eaten the young *Datura stram.* plants. A thorough examination of the weed-patch (the old house place), made by Mr. Silver, his son, and myself, revealed the fact that nearly every one of the young blooming *Datura* plants, except where they were exceedingly thick, or where some old ones had been left standing, were more or less mutilated. Some of them lacked more than half of the whole plant, while others only lacked several leaves, a flower or a young seed capsule. It also became evident, considering the manner in which horses and cattle, respectively, take up their food, that not the latter, but the former had bitten off what was wanting. Besides, the whole patch was almost entirely destitute of cattle excrement, and contained a great deal of comparatively fresh horse voidings, probably to a greater extent than any other part of the field of equal size. All this, however, may constitute only a part of the causes. The other part, in my opinion, must be found in the following: Mr. Silver, who only last May bought the farm—which, by the way, is a sadly neglected piece of property, and has been under litigation for several years—has no stable. The horses and mules, therefore, were exposed night and day, before and after coming from work, to all the wet and cold weather we had last month. This, I think, constitutes at least one of the causes, and may be the principal one, although I do not doubt the rotten oats, the *Datura stramonium*, and possibly the water, acted as narcotic poison, and considerably contributed in bringing on the paralysis. My opinion is that if the fungus growth in the rotten oats and the narcotic *Datura stramonium* plants had not acted upon and seriously affected the centers of the nervous system, the effect of the exposure to cold and wet would have been a less severe one, or probably would have manifested itself in a different direction. However this may be, I am quite certain that the causes of the death of five animals out of six are of a local nature, and that the paralysis, or, if preferred, *cerebro-spinal meningitis*, is not of an epizootic character. Up to date no other cases have occurred in that neighborhood. It must yet be mentioned that, as reported by Mr. Silver, the mule which died first was an exceedingly greedy eater—

DISEASES AMONG HORSES IN ILLINOIS.

Microscopic Investigation by Dr. H. J. Detmers. **PLATE I.**



Objects found in the water of the well of Mrs. Silver's pasture. ×900.

1, 1.—Micrococci.

2. 2.—Dead Monads.

3.—Living Monads.

4. 4.—Apparently spores looking like ustilago maidis.

5.—Ustilago carbo, not found in the water, for comparison taken from oat smut.

Objective: Tolles homogenous immersion, 1/10

rfect glutton; the three young horses (two mares and one gelding) very greedy eaters; the mule which died last was sick a whole , and therefore had a much milder or less acute attack than the animals, was a very good though not so greedy an eater as any of thers, while the eight-year-old horse, which alone survived and re ed exempted, is very dainty at his food. Further, the well in the ure furnished the water for drinking for the horses and mules which . but, excepting once or twice, not for the horse which did not be affected.

lieving that further comment is unnecessary, the above is respect submitted.

H. J. DETMERS.

HAMPAIGN, ILL., *November* 18, 1881.

ANTHRAX AMONG CATTLE IN NEW JERSEY.

n. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: The following is the history of an outbreak of disease which oc rred during the year 1881 in the excellent farming and dairy section Mannington Township, Salem County, about two miles from the city Salem, New Jersey:

Mr. Hogan has lived on the farm now occupied by him nearly four ars. He generally owned about 30 cattle, and sold milk. The farm is a good state of cultivation. The pasturage is high land with the ex ption of a large marshy field, which affords yearly grass without plow g, and is therefore much used. In this field a cow was found dead in une. The animal was four months advanced with calf, was in good con ition, and had not been noticed as being sick.

A second cow died about two weeks after, being in much the same ondition as the other, not having been noticeably sick. A third cow lied in the same way a week after. About the last of July or early in August a fourth cow died, having been sick one day. All these cows were in calf, but not near the full period.

Soon after this two of the horses which pastured in the same field died, one being four years old and the other two. The horses had stopped eating and seemed moping. One was sick forty-eight hours.

The fifth cow died early in September, and after this the sixth, seventh, and eighth. None of them were sick over one day. One died twenty-six hours after calving, and the calf died two or three days after.

The owner opened some of the animals, and although he was not aware of any cut or scratch, about three days after one examination he had a swelling of the hand and fore arm, which was treated by a physician in Salem who regarded it as resulting from this dissection. He recovered without further symptoms. Early in September the State board of health had notified (the disease being suspected as pleuro-pneumonia) Dr. Miller, of Camden, and Dr. Rogers, of Westville, veterinary inspectors of the board, who made three or four visits, examined into the facts, and made a *post-mortem* examination of one of the dead animals. The conclusion arrived at was that it must be a form of anthracoid disease.

A lung that had been put aside for examination was pulled out of a basin and dragged off by a dog, and two large hogs gc
One of these died the next day, and the other was very

premature birth one month ahead of time to several dead pigs, but afterwards recovered. Late in September a neighbor's bull broke into the pasture and was with the cattle two days. He was taken home, and the second morning after was found unable to get up, and died in a half hour. Some of a neighbor's cattle had been in the field, and two neighbors had pastured in adjacent lots, but none of the cattle had suffered.

October 29 another cow died. Those about springing seemed to be most liable to the disease. Only one was giving milk, and she had shrinkage of milk at one milking only. As six weeks had elapsed we had hoped that the disease had disappeared the last of September. The township committee, or board of health, had been in correspondence with us, and the herd had been quarantined from our first knowledge of the outbreak. After notice of this last case I visited the herd and found the owner's best horse had died of the disease the night before.

I could find no trace of unusual disease on other farms. One new cow had been bought since February, and she was bought of a neighbor who raised her. She was alive and well. As I had not expected to find a case of the disease at this visit, I had no veterinarian with me, but proceeded to an examination myself. I found no lesions about the throat or upper windpipe. The left lung was intensely congested—so much so as to admit of no air. There was abundant effusion of yellowish water into the right pleura. The spleen weighed five pounds after some thick blood had oozed from it. In addition to its size it cut easily, and was in parts much mottled. The liver was engorged, and about two pounds of it so friable as to look like chocolate grounds. The heart was normal. The stomach and intestines were examined, but there were no signs of active congestion discovered. There had been the usual defecation and secretion of urine, and so no examination was made of the kidneys. Blood for microscopical examination was taken from the jugular vein in two bottles and taken by me to Dr. Satterthwaite, president of the New York Pathological Society and lecturer in the Columbia Veterinary College. Before the *post-mortem* examination I had looked carefully over the herd. No one of them showed signs of any present sickness, and their condition seemed very good. During the summer, on account of short pasture, they had been fed rather more meal, bran, and hulls than usual.

One cow having a bunch under the jaw, I was led to inquire its cause. The owner said it was a cow he had owned two or more years. He had purchased it of a neighbor who had raised it. The tumor was hard and had been growing quite a while. He had not known it to discharge. I requested that the animal be placed in a stable for examination. I found at least two points where it must have discharged, and one part from which I could get a very little pus, the odor of which, on close approach, was very unpleasant.

On inquiring of those who attended most to the cattle, I found that there had been, three or four months before, considerable discharge, and that now and then it seemed to exude a little matter. The cow, although not seemingly sick, was not thrifty. The tumor was hard and deep, and different from bunches sometimes seen on cattle. The owner had called it a hard cancer. As to the other cases which had occurred, Drs. Satterthwaite and Dana, of the Veterinary College, were so well satisfied that the disease was anthrax that they advised the burning of the carcasses. Abundant bacteria were found in the blood, and further experimentation instituted. We had before this fully canvassed the relation which the cow with a tumor might bear, either as a primary or exciting cause of the disease, and thought it best that she should, as a matter of precaution, be slaughtered. I communicated this view to the owner and to the assessor, and arranged for another visit on November 18. It was not thought best to kill her at that time.

While the veterinarians, Drs. Miller and Rogers, who had been in attendance, as well as those to whom the blood had been submitted, agreed that the disease was anthrax, it could not be affirmed that the *Bacillus anthracis* had been found. The blood itself was taken after death and clotted rapidly. Although a large number of experiments were made, and some rabbits and other animals died after inoculation, the microscopists could not rest a diagnosis upon this evidence. It seemed important to ascertain whether the cow with a tumor could have infected the other animals, either by reason of their licking it or by drops that had fallen on the grass. The owner and the local board of health came to the conclusion that the cow had better be killed. As there was doubt as to the authority of the State law in such a case, application was made to the Commissioner of Agriculture for authority to slaughter the animal and institute some experiments at a limited expense to his Department. Such permission having been granted, the cow was killed January 2, 1882, and the tumor carefully dissected by W. B. Rogers, D. V. S. It was separated entirely from its connections, but a part of the lower jaw was necessarily removed with it. The next day a pig, which had been procured for the purpose, was inoculated by Dr. Rogers with the first pus from the tumor. In order that there might also be a test from the juice and substance of the tumor, the next day I inoculated another pig in two places, introducing under the skin a small portion of the tumor containing the juice. These pigs were carefully watched from day to day. They had not the least sickness, and no serious local effect occurred. So far as the experiment was carried there did not seem to be any connection between this growth or its discharge and the fatal disease which had affected horses, cattle, hogs, and sheep on this farm.

Herewith we subjoin an outline of the microscopical examination as made by Drs. Satterthwaite and Porter:

Special report on the diseased lower jaw taken from a cow killed by order of the New Jersey State board of health, acting under the authority of the honorable Commissioner of Agriculture.

The specimen to which the subjoined description applies was placed in the hands of one of the undersigned (T. E. S.) by Dr. E. M. Hunt, secretary of the New Jersey State board of health, on January 6, 1882, and the history of the case as given orally was as follows:

"A cow, nine years old, belonging to Michael Hogan, of Salem County, New Jersey, had suffered for over two years from a tumor of the lower jaw. The neoplasm implicated the body of the left inferior maxillary bone, and had increased gradually in size for about one year, when suppuration was first noticed, the odor from the material discharged being offensive. Subsequently the discharge stopped, but later it again appeared. In view of the anthrax epidemic that had prevailed in and about this special locality, it was deemed advisable to kill this animal, and determine, if possible, whether or not this diseased jaw was in any way connected with the origin and propagation of this epidemic."

Removal of the soft parts revealed the chief characteristics of the disease, and the growth was found to occupy and involve the greater portion of the left half of the body of the inferior maxillary bone, extending to within twelve centimeters of the symphysis and three centimeters of the angle. Its measurements were: Length, 23 centimeters; greatest depth, 7½ centimeters; greatest breadth, 6 centimeters. The body of the left inferior maxillar measured horizontally, in all, 38 centimeters.

In external appearance it had some resemblance to an osteo-sarcoma, such as frequently occurs in this situation. It lacked, however, the delicate "egg-shell" envelope of new bone, the external surface being, on the contrary, dense and hard, resisting and rough, while upon the outer aspect two large, irregular openings led into the interior of the bone, serving as the outlet for the grumous and offensive matter alluded to. A probe introduced into these openings did not pass through the bone proper, but led into rounded cavities whose walls were more or less carious; and thus the dissimilarity between this disease and osteo-sarcoma became more apparent. To decide the question with absolute certainty and determine the true nature of the disease, a horizontal antero-posterior section was made entirely through the growth on a level with the fangs of the teeth. It was then seen that an irregular medullary cavity ran longitudinally along the outer side of the mass, and that at its two extremities were two large spaces imperfectly cut off from the medullary cavity, and communicating with the external air by the openings already alluded to. In these spaces was the offensive material. The greatest deposit of bone was noticed upon the inside of the jaw, and here the bony tissues exhibited all the various phases of bone development and rarefication seen in all inflammatory bone-formative processes.

The outer surface of the bone was marked by eminences and depressions, and its inner border had an especially knobbed and notched outline. The periosteum also was notably thickened in places, especially where the bony walls of the cavity were thin, and it also showed indications of abscesses that had occurred during life (chronic periosteal abscesses). The thick material in the abscesses of the bone was composed of rounded bodies, undergoing cheesy degeneration. The firmer portions were found to be composed of tissues showing fibrillation, and more or less interspersed with small oat-shaped bodies and leucocytes. This material was not markedly vascular, but here and there minute extravasations of blood were found. In the medullary cavity the ordinary marrow was replaced by a loosely-fibrillated connective tissue. No giant cells were seen, nor was there any tissue that would indicate that there was a sarcomatous element present.

The disease was evidently a chronic suppurative ostitis, accompanied by a suppurative periostitis. At first it was thought that the primary trouble was peridentitis, but careful dissection failed to show any extended destruction of the periodontoid membrane, which would exclude this anatomical part as the seat of the original trouble. From the general outline of the growth, it seems probable that the primary lesion was the chronic suppurative periostitis, which was finally masked by the suppurative ostitis.

THOMAS E. SATTERTHWAITE, M. D.
WILLIAM HENRY PORTER, M. D.

SCHOOL OF HISTOLOGY AND PATHOLOGY,
New York City, January 27, 1882.

Since the date last mentioned there have been no new cases of the disease, and the farm was released from quarantine a few days since. We shall watch with some anxiety to see whether there is any recurrence of the disease next summer. The section is one which has been very free of cattle diseases.

It is alleged, however, that for many years there have been losses of horses from the disease usually known as "staggers." It is sudden in its onset, and has by some farmers been regarded as more frequent to young animals and to those pastured on the low lands. The rich alluvial deposits of this section are in places such that sand is carted upon the soil in order to mix it or dilute the organic matter. Anthrax and this malady are alike regarded by some as "malarial" in their character. The question is not infrequently asked whether these diseases have any casual relationship. It will be well worth while either for the State or the general government to investigate the *post-mortem* appearances of horses dying of this disease, so as to ascertain whether the spleen and liver show any corresponding lesions. We shall hope to aid in any other efforts to throw light upon this sudden fatal outbreak or upon the causes of this more common disease among horses.

Respectfully submitted.

EZRA M. HUNT, M. D.,
Secretary State Board of Health.

TRENTON, N. J., *February* 6, 1882.

ENZOÖTIC CEREBRO-MENINGITIS AMONG HORSES IN TEXAS.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: In company with Major D. W. Hinkle I left San Antonio on the 2d of July for Laredo and San Diego, where I visited some sheep ranches in Duval County, and arrived on the evening of July 5th at Corpus Christi. My object in visiting Corpus Christi was to look after some recently imported Northern cattle, which were reported to be dying of so-called Texas fever. Before arriving at Corpus Christi we learned of the existence of a very fatal enzoötic among the horses in the vicinity of the coast. As soon as my presence in Corpus Christi became known I was requested by Dr. Hamilton and others to examine a valuable horse affected with a "mysterious" or "new" disease, of which a large number of horses had died, and which had proved to be fatal in nearly every instance. Although tired from a long and tedious journey I at once complied with the request. The animal, a middle-aged mare of evidently improved Texas stock, had been affected since the 4th instant. Before my arrival she had been bled, repeatedly drenched with solutions of saltpeter, bromide of potassium, &c., and for a short time ice had been applied to her head. She belonged to a physician who happened to be absent, and all other physicians in town, three or four in number, had offered their advice, hence the complicated and incongruous treatment. I found the animal in an unconscious, almost comatose, condition, now and then blindly staggering about, hardly able to stand on her legs, and almost constantly pressing to the right. The abdomen was considerably drawn up, the extremities felt rather cold, the temperature in the rectum was 102.4°F., and the pulse very feeble and about 48 beats to the minute. The respiration was slightly accelerated, and on ausultation a faint rubbing sound could be heard in the bronchi. Some appetite was yet existing, because food offered was not refused when put into the animal's mouth. The bowels and urinary organs, I was informed, had not acted for some time; at any rate the rectum, when the thermometer was introduced, contained some very dry excrements. The color of the visible mucous membranes did not appear to be very abnormal; still, as the first examination was made by lamplight, I have to leave that point undecided. My diagnosis was: "Cerebro-meningitis of a typhoid character."

July 6th.—Finding the report that about 500 horses had died in the vicinity of Corpus Christi confirmed, Major Hinkle, who is the associate editor of the *Texas Live-Stock Journal* at Fort Worth, telegraphed and asked you to order me to make an investigation of the prevailing enzoötic. I received your answer the same evening about 4 o'clock. Meanwhile, not doubting what your answer would be, I endeavored to see and to examine as many affected horses in Corpus Christi and neighborhood as possible, but particularly such as had not yet been subjected to any medical treatment. All the sick horses I could find or hear of presented almost precisely the same symptoms as given above, except that some, instead of pressing to the right, pressed to the left, while others merely pressed backward or forward, but the majority of those I saw (whether accidental or not I do not know) attempted to move in a circle to the right. My diagnosis—cerebro-meningitis—consequently received confirmation. I should yet mention that none of the patients I saw exhibited plain symptoms of an affection of any portion of the spinal cord posterior to the medulla oblongata. The animal I saw first on the evening of the fifth was yet living. I had ordered an application on the poll of oil of cantharides (1:4), as a counter-irritant, which had been made and was acting. Finding it unadvisable and even dangerous to give much medicine to an unconscious and comotose animal, and hardly able to swallow anything, I had only prescribed a few pills, principally composed of aloes and calomel, for the purpose of removing the constipation. Whether they were properly administered or not I do not know; at any rate, they produced no action. I therefore applied an enema of soapsuds, which also remained without effect; the bowels did not react.

On making inquiries of people who had lost horses, whose horses had become affected, or who had an opportunity to observe the workings of the disease, I learned: 1. That but very few animals affected had survived, and that most of those which did survive were showing more or less symptoms of so-called "blind staggers," or of a continued pressure upon the brain. Nobody seemed to be able to report a case of perfect recovery. 2. That not a solitary horse confined to the stable and had received water for drinking only from a well or a cistern had become affected, and that all those horses which had contracted the disease had been running out and had taken their water for drinking for some time and to some extent from some open pond, ditch, pool, or so-called tank. (In Southern Texas "tank" means an artificial pond, usually of small size.) This, of course, gave a hint, and, together with Dr. Spohn, city physician, I collected water from five different places in and near the city. These five places, I was told, furnished water for drinking to a large number of horses. The water in each instance was carefully taken from just beneath the surface at such points as appeared to be most accessible to the horses. The first sample was taken from a pond or so-called tank of medium size, situated near the shore of the bay, and in close proximity to a recently-established steam laundry; the second was from an open trough, which contained well-water from a closed well; the third from a large open trough or basin, which received its water from a large open well or reservoir in the ground; the fourth was from a large pond, covering several acres, outside of the city—a pond which furnishes water for a large number of horses and cattle—and the fifth was taken from a small, but apparently deep, pond or water-hole, which furnishes drinking water, not only for horses, but also for some Mexican families. The large pond, from which sample No. 4 was taken, is situated over half a mile northeast of the city, and separated from it by a rise of ground. The water it contains is rain and surface water, run into it from all sides. In the rise of ground between the pond and the city are several small ravines, or washouts, produced by heavy rains, all sloping towards the pond. These washouts were made use of by the people as a burial, or rather dumping-ground for their dead horses, which latter were only partially covered by a few inches of dirt, and produced an unbearable stench. Toward the east end, but not far from the middle of the large but rather shallow pond, was the carcass of a dead horse lying in the water, and close by a large number of cattle and several horses were drinking. The next heavy rain will wash all the decomposing horses buried in the washouts piecemeal into the pond or tank. What the effect upon the water will be can be easily imagined.

In the evening all five samples of water were subjected to a careful microscopic examination.

The diseased mare, seen first on the evening of the fifth, was not only alive on the afternoon of the sixth, but even slightly improving. The counter-irritant had acted, and the brain, to all appearances, was a little freer. The man in attendance, an old negro, however, had applied, contrary to my orders, a second blister, and immediately, with his dirty hands smeared all over with cantharides, had taken hold of the animal's tongue for the purpose of giving more medicines, also contrary to orders. As a consequence the whole lower portion of the tongue was fearfully inflamed, covered with blisters and sores, and hanging out of the mouth. In addition, some so-called horse-doctors had been allowed by the wife of the owner to administer drenches, to smoke the head, and to apply hot water to the feet of the animal. In consequence the whole aspect of the disease was changed; some of the drenches had been poured into the lungs; the latter, in consequence, had become congested and inflamed, and it was therefore no object to me to spend any more time on that animal. It died two days later, probably of pneumonia.

I was anxious to make a few *post-mortem* examinations, but the disease, it seemed, had nearly run its course, and although two or three horses died every day while I was in Corpus Christi, the people, more desirous of having their horses treated (doctored) than of giving me assistance in my researches, never informed me of it till the next day, when the carcasses were decomposing. It was very warm—the mercury went up to 100° every day—and they decomposed very rapidly.

It should here be mentioned that Major Hinkle, who knows nearly every stock-raiser in Southwestern Texas, and went with me to Duval and Nueces Counties to facilitate my work by introducing me to his stock-raising friends and acquaintances, took sick the first day we were in Corpus Christi, otherwise I might have succeeded in getting, in some instances at least, more timely information as to the animals that died.

It will not be necessary to give a detailed description of the symptoms, &c., of every diseased animal examined, because the disease proved to be in every instance essentially the same. Consequently, a special mention of a few cases will suffice to illustrate the nature of the enzoötic.

Mr. Lawrence, three miles from Corpus Christi, lost five animals, has one colt sick, and two horses yet healthy. Till within two weeks of date (July 6) all his horses were running out and drinking pond-water, but during the last two weeks those yet alive received only well-water. The first horse died three weeks since; the second animal, a mare, died soon after. Another one died just before the horses were taken from the prairie and confined to well-water for drinking. A mare, the dam of the suckling colt now sick (July 6), died ten days since, but became affected about the same time the dam was stabled or taken from the prairie. The colt of the first mare died about the same time, and the colt now diseased showed the first plain symptoms yesterday. It is now in a semi-comatose condition, staggering and pressing to the right, and apparently blind; in short, exhibits the same symptoms as described above. Prescribed a counter-irritant externally and saltpeter internally.

Mr. E. P. Dougherty, who claims to have as much experience concerning the enzoötic as anybody, estimates the losses in the neighborhood of Corpus Christi, or in a district along the coast extending about twenty-five miles in either direction—east, north, and west from that city—at five hundred head of horses, and says the mortality ceases in every instance a few (5 or 6) days after the animals are removed from the prairie and confined to well-water for drinking and to dry food. He also looks upon grazing in the dew as dangerous.

Mr. William Cody, on the Oso, twelve miles from Corpus Christi, lost six saddle horses and a good many stock horses. On his ranch, too, no further attacks took place after the horses were taken up and confined to well-water for drinking. In short, all those who have made observation, and who claim to have experience in regard to the disease, seem to agree that only such horses become affected as are allowed to drink the water of pools, ponds, or so-called tanks and ditches, and to graze while the dew is on the grass. Those animals which are kept in the stable and confined to well-water for drinking seem to remain exempt. Further, that the disease in a few days ceased to spread after the horses were taken off the prairie and confined to well or cistern water for drinking.

There is yet one other point in regard to which there seems to be no difference of opinion, namely, that horses in good flesh, or rather plethoric, suffered much more, and became affected much sooner, than those in a comparatively poor condition. A few persons even claimed that horses thin in flesh remained altogether exempted. However that may be, I must admit that all those affected with the disease, which I had an opportunity of seeing, were in good condition.

One other case deserves special mention. On July 8 I was called by Mr. Thomas Warren, in Corpus Christi, to a horse recently diseased. I found the animal a rather strong, middle-aged working horse, muscular and in good flesh, though not fat. It had been running out on the prairie, became affected during the night or on the previous evening, and when found to be sick was not allowed to run out, but was kept in the stable-yard at home. The pulse was yet strong, or nearly normal, and did not exceed forty-eight beats in the minute. It possibly was even lower, but as the horse was unconscious, and threatened to fall down at any moment, it was impossible, and even dangerous, to make an accurate examination. All mucous membranes which I was able to examine exhibited a normal appearance. The animal was apparently yet able to see, but staggered very much, and had no control over its motory apparatus. He unconsciously pressed alternately forward and backward, staggered and reeled from one side to the other, and came often near falling; but when apparently ready to fall usually regained sufficient control to remain on his legs. When offered food or water he showed some desire to eat and drink, and sometimes took a bite of food or a swallow of water. The owner had rubbed in oil of turpentine on the poll, and had drenched the animal with a mixture containing resin and some other things. I prescribed externally some oil of cantharides, to be applied as a counter-irritant on the poll, and internally saltpeter and carbolic acid, to be given in the water for drinking and in the food.

July 8 (in the evening).—Mr. Warren's horse shows decided improvement. The counter-irritant acts nicely; the staggering and reeling to and fro is much less; the animal can see, and eats and drinks some, but the pulse, although not very weak, is slow, and down to thirty beats in a minute.

July 9.—Mr. Warren's horse is in a very promising condition; he walks about in the yard, has regained considerable control over his motory apparatus; the staggering is much less; the appetite is tolerably good, at least when food or water is offered from a distance of a few yards he invariably comes and takes it, and thus gives proof that he can hear and see. The pulse is thirty-two beats in a minute, and the temperature nearly normal.

July 10 (in the morning).—The horse is nearly all right; but very little staggering or unsteadiness in walking can be observed; appetite, digestion, respiration, &c., appear to be normal; the pulse is yet a little too low—thirty-five beats in a minute—and the temperature is the same as that of a healthy horse.

MORBID CHANGES.

For reasons already stated, the chances of making a *post-mortem* examination of an animal, in which the morbid process had not been affected by medical treatment or quackery, were rather slim. Fortunately, I became acquainted with a stockman by the name of John Dunn, who had lost several horses, and who, not having any dead horse just then—the disease on his ranch had nearly run its course—was liberal enough to offer the sacrifice of a sick colt, the dam of which had died a week since. Mr. Dunn, on the 8th of July, took me out to his ranch, about four or five miles east of Corpus Christi, and several gentlemen of that city, among whom I will mention Dr. Spohn, Rev. Rogers, and Mr. Dougherty, went with us. The colt, an animal about four or five months old, had been sick fully forty-eight hours, consequently the disease was at its height. The colt appeared to be unconscious and unable to see. It tumbled and reeled about, sometimes to one side and sometimes to the other, but probably more to the right than to the left. Its abdomen appeared to be drawn up. Its pulse was feeble or scarcely perceptible, but probably too low, or at least not accelerated. The beats of the pulse could not be accurately counted, because the animal was constantly staggering and tumbling about. The temperature in the rectum was 102°F., or maybe half a degree higher, as the thermometer could not be applied the usual length of time. All visible mucous membranes presented an almost normal appearance.

The colt, after it had been examined as thoroughly as circumstances permitted, was killed by being stabbed in the heart, and thus bled to death. The blood presented a perfectly normal color. At the *post-mortem* examination, which was made by myself in the presence of the above-named gentlemen, the following changes were observed: On opening the skull the dura-mater was found to be morbidly affected. The morbid changes, consisting in some swelling of the membrane and considerable congestion, and more or less stagnation of the blood in the blood-vessels, appeared to be the most developed over the longitudinal fissure and the adjacent parts of the anterior surface of both hemispheres, but were more extensive toward the left than toward the right, and much more extensive or plainly developed over the hemispheres of the cerebrum than over the cerebellum or any other part of the brain. When the dura-mater was removed the cerebrum presented, especially in the upper and anterior portions of both hemispheres, considerable congestion but no extravasations of blood, while the cerebellum, medulla oblongata, and other portions of the brain exhibited, externally at least, a nearly normal appearance. Continuing the examination, the choroid plexusses (veins) were found to be gorged with blood, and the ventricles of the brain, particularly the two lateral ventricles, but also the third, appeared to be distended or abnormally large, and were full—contained a large quantity—of an almost clear serum, while the surrounding tissue presented an œdematous appearance. No other morbid changes could be found. After I had opened the skull, I also opened the other large cavities of the body, the chest and the abdominal cavity, and examined all the viscera, but was not able to detect any morbid changes, except some comparatively slight swelling or enlargement of the mesenteric glands. Lungs, heart, liver, kidneys, intestines, &c., appeared to be perfectly healthy. The stomach and intestines, when opened, did not only not exhibit any morbid changes, but also were free from any entozoa, bots, &c. The stomach was nearly destitute of food, but the large intestines contained a considerable quantity of feces, which, towards the rectum, appeared to be unusually dry, showing that the animal had been constipated.

This was the only *post-mortem* examination I had an opportunity of making; but the result, that is, the morbid changes found, according to Mr. Dougherty, who stated that he had made several *post-mortem* examinations before my arrival, did not differ from what he found in other cases. Still, judging from the symptoms observed in living animals, I have no doubt that in some cases, instead of the hemispheres of the cerebrum, the cerebellum and other portions of the brain may constitute the most affected parts.

When the colt was killed, a small vial was filled with blood just as it flowed out of the heart (the right ventricle), for the purpose of further examination under the microscope. I also took a diseased portion of the dura-mater for microscopic examination, but on account of the great heat could not very well examine it in its perfectly fresh condition, and therefore put it immediately in a preserving fluid.

THE CAUSES OF THE ENZOÖTIC.

In order to convey a correct idea of what probably, or almost beyond a doubt, constitutes the main cause of the enzoötic, it will be necessary to state where and when it commenced, and to give a brief description of the country, or rather strip of country, in which the disease originated and prevailed and to which it remained limited.

The disease made its first appearance about the end of the first week or the beginning of the second week in June, on the "Juan Sais" ranch, 10 miles west of Corpus Christi, and from there very soon spread in every direction. It remained limited to a strip of country along the coast of about 50 to 60 miles in length and not more than 25 miles in width, that is, extending that far inland. Corpus Christi may be considered as about the center of this strip or belt along the coast. It is a low and almost perfectly level country; a close observer, however, will see that comparatively narrow strips, running nearly parallel with the coast, are a trifle lower than the rest of the land. These narrow strips are destitute of brush or chaparal, and covered only with a somewhat coarse grass and such other plants as prefer to grow on ground inclined to be wet, while the balance of the land, though almost destitute of trees, is more or less densely covered with brush. About 4 or 5 weeks before my arrival in Corpus Christi they had very heavy rains, at least so I was informed, but since then very dry and hot weather has prevailed. In consequence of the heavy rains, all the lower strips of land, the so-called "swales," receiving all the wash from the higher, much broader, and chaparal-covered strips, became inundated, temporarily at least. When it stopped raining a rapid evaporation took place, and the water not evaporated soon collected in the numerous ponds, ditches, so-called hog-wallows, water-holes, &c. This water, however, not filtrated through the ground, was surcharged with organic substances, and new organic life was soon developed. A microscopic examination, particularly of water-samples 1, 4, and 5, proved to be full of micrococci, bacteria, spirilla, and *bacilli*. Only in No. 5 no *bacilli* could be found, and No. 2 was the only sample nearly destitute of organic life, while Nos. 1 and 4, taken from ponds which furnished drinking water to a large number of horses, which afterwards became affected with the disease and died, were full of all kinds of schizophytes. As before stated, a sample of blood was taken directly from the heart of the colt killed by bleeding, and was microscopically examined as soon as I returned to town, consequently while yet perfectly fresh. It also contained a considerable number of micrococci. It must be mentioned, however, that when I went to Corpus Christi I did not know anything of the existence of the horse enzoötic, and expected to find entirely different work on the cattle ranches. I therefore had no microscope with me, and was compelled to examine the samples of water and the blood with a comparatively inferior instrument and a ¼ dry-working objective of Beck, belonging to Dr. Spohn, who had the kindness to offer to me the use of his instrument. So it happened that I neglected to make any drawings of the schizophytes found, because I intended to take the water with me to San Antonio and there make a more thorough examination. I took the samples with me, but as I did not arrive at San Antonio until the 13th, and as they were collected on the 6th, and every vial not only well filled but also well closed, most of the organisms, probably for want of oxygen, had disappeared when I made the second examination with my own instrument. The result, therefore, remained unsatisfactory. Still, as the water when examined immediately after it was collected was swarming with schizophytes, and as all observers agree that only such horses became affected as had been drinking that kind of water, and as farther north, where the land is less level and more elevated, where swales and a less number of water-holes exist, and where the rainfall had been much less, no horses became affected, there can hardly be any reasonable doubt that the water of the ponds, "hog-wallows," ditches, and water-holes constituted the main cause of the enzoötic. In other seasons or other years the rainfall is either much less, or, if not, is not immediately followed by such continued hot and dry weather as was recently the case in that strip of country in which the enzoötic prevailed; hence, in other years the peculiar conditions which it seems produced the main cause of the disease are not existing, or at least not existing to a sufficient extent. Further, the disease everywhere disappeared as soon as the water-holes, ponds, hog-wallows, ditches, &c., became dry (about the time of my arrival), or as soon as the horses were again compelled to go to their usual watering places, the Nueces River, the Agua Dulce, &c., or to the large artificial ponds (tanks), wells, or cisterns for their drinking water. That the morbid process exclusively affected the brain and its membranes finds, probably, an explanation, if the necessary effect of the continued high temperature of the almost cloudless skies, bright sunshine, and want of shadowy places (trees) is taken into consideration. Finally, the observation that only plethoric horses, or such as were in good flesh, became affected, is probably correct, because plethoric animals are much more predisposed to congestions and stagnations of blood in the capillaries than animals which lack blood or are in poor flesh. Captain Kennedy, one of the principal land-owners and stock-raisers in Southwest Texas, asserts that he has suceeded in stopping the disease on his ranch by bleeding every horse not affected till weakness superseded. Hon. N. G. Collins, another large stock-raiser, who resides in San Diego, but owns considerable land and live-stock in the coast district, has come to the same conclusion and also advocates bleeding as a means of prevention.

If the observations of these gentlemen are correct, and I have no reason to doubt that they are, the same result depleting the animal system or causing the animal to become less plethoric may also be accomplished by other means, for instance, by giving physics or diuretics, by keeping the animals a little short, or, where practicable, by acidulating the water for drinking by adding a small quantity of some mineral acid. As a possible source of an auxiliary or predisposing cause the following may yet be mentioned: In the vicinity of Corpus Christi they had, this spring, particularly in May and the first part of June, copious rains, which caused a rapid and luxuriant growth of grass and thus produced extraordinarily good pasturage; consequently, horses and other live-stock had plenty to eat, rapidly gained flesh, and, if I am correctly informed, were, in June, on an average, in a better condition as to flesh than is usual at that season of the year.

Still, the best and surest means of prevention proved to be to take the horses to be protected off the ranch, to keep them in a stable, yard, or corral, and to water them exclusively from a well or cistern till the danger of becoming affected had passed, or what is the same, till the pond, water-holes, &c., become dry. Wherever that was done no further outbreaks occurred except in such animals as had previously become infected. At any rate no other measures of prevention and not even a separation of the healthy animals from the sick ones were found to be necessary, because the disease, although infectious—it probably is communicated to a suckling colt by the milk of its dam if the latter is diseased—is evidently not contagious.

DURATION, MORTALITY, AND TREATMENT.

Judging from those cases that came to my knowledge, I have to conclude that the period of incubation does not exceed eight days, and in most cases probably not more than four to six days. The duration of the disease, or the time which elapses between the appearance of the first symptoms and the usually fatal termination, is from one to three days, seldom longer. It is true, some horses affected with the enzoötic died after a sickness of four, five, or six days, and maybe even later, but these animals, I have good reason to believe, would have survived if nothing had been done to them; they did not die of cerebro-meningitis, but in consequence of the treatment they received. They were all animals which had been repeatedly drenched, and being unable to swallow, to a certain extent at least, there can be no doubt more or less of the drench was poured down into the lungs. Some of the Corpus Christi horse-doctors, finding that the sick horses did not want (?) to swallow what they intended to give them, poured their nostrums in through the nose. Comment is not necessary—at any rate it is a fact that nearly all the horses that died after the third or fourth day died of pneumonia, brought on by pouring medicines into the lungs.

Some of the Corpus Christi physicians prescribed application of ice on the poll of the animals, and the result, probably, would have been a favorable one if the owners of the animals had continued those applications for a sufficient length of time, but that, as far as I could learn, was never done. In most cases either but one application was made and the ice put on soon melted, or the ice was not secured in its place and soon dropped; consequently, the result was just about the opposite of what the physicians expected it would be. The cooling was only temporary, and before it could produce any favorable results a reaction set in and the disease invariably took a turn for the worse. I therefore recommended a different course and applied counter-irritants, apparently with very good results, and gave internally almost exclusively only such medicines as seemed to be indicated and were voluntarily taken, either with the water for drinking or with the food, because it soon became apparent that the excitement of the animal, caused by using force in giving medicines, did far more harm than the medicine could do good.

Besides that, it is a well-known fact most medicines have at best but very little effect where the center of the nervous system is morbidly affected. Only two, or perhaps three, animals were treated strictly in accordance with my directions, and both recovered. The owner of the third animal failed to report.

The mortality was very great. If the statements made to me by different persons are correct, not more than 5 or 10 per cent. of all the horses that became affected survived, and in most of them the recovery was only partial or incomplete, because considerable pressure upon the brain, caused probably by an accumulation of fluid (exudation) in the ventricles, remained and made the animals worthless.

Very respectfully submitted.

H. J. DETMERS.

SAN ANTONIO, TEX., *August* 10, 1882.

EXTRACTS FROM LETTERS OF CORRESPONDENTS.

INTERLOBULAR PNEUMONIA AMONG CALVES.—In December last Dr. H. J. Detmers was directed by the Commissioner of Agriculture to investigate an outbreak of disease among calves in Henderson County, Illinois, which at the time was thought to be that of contagious pleuro-pneumonia. After a visit to the herd and a thorough investigation of the malady he submitted the following report:

On the 19th instant I received a letter from Hon. James Peterson, of Oquawka, Henderson County, Illinois, requesting me to come and examine a herd of Eastern calves afflicted with a fatal disease, which was, or feared might be, contagious pleuro-pneumonia. I at once forwarded the letter to you, and, to save time, took the first train to Oquawka, where I arrived about noon the next day. The cattle, I learned, were at Rozetta, about 5 miles from Oquawka, and the examination was postponed to the next day, December 21, on account of rain, at the request of the owner of the cattle, Mr. Kennedy. Next morning Mr. Peterson and myself went to Rozetta, where we found on the premises of Mr. Kennedy, in a large feed-lot by themselves, about 40 head of Eastern calves, many, or perhaps most, of them evidently diseased, very much emaciated, and in very poor condition.

Mr. Kennedy, I learned, had bought in the Chicago stockyards, on September 7, 60 head of Eastern calves, alleged to have come from *Western* New York. They were nearly all rather young and small, but otherwise, according to Mr. Kennedy, did not appear to be unhealthy at that time, nor did any of them exhibit plain symptoms of disease until about the latter part of October or beginning of November.

In November they began to die, and on my arrival 20 calves of the original 60 had died, the last one on the morning of the day of my arrival. Mr. Kennedy and his neighbors became alarmed; not so much on account of the actual loss, but because of the possibility that the disease, which manifested itself as a very fatal lung malady, might prove to be the much-dreaded pleuro-pneumonia. Therefore strict inquiries were made as to the part, or parts, of New York from which the calves had been brought. It was alleged that they had come from Western New York, but it was found they had been raised in the eastern parts and from there sent to Western New York to be shipped to Chicago. On learning this the anxiety of Mr. Kennedy and his neighbors was increased.

As I found many of the surviving calves diseased, and some in an almost dying condition, I had abundant material for examination, and found in every case lobular pneumonia. In a few animals the disease was attended with more or less affection of the pleura, and in several it was found to be complicated with accumulations of exudation (dropsy) in the chest, abdominal cavity, and subcutaneous tissues. The temperature in the rectum of the animals examined ranged from 101° to 103° F., and an auscultation of the thorax revealed in every animal abnormal sounds, but in none that absolute silence characteristic of an advanced stage of pleuro-pneumonia, and the percussion sound, too, was more resonant than is usually the case in the latter disease.

As one animal had died an hour or two before my arrival, and this afforded a good opportunity for a *post-mortem* examination, it was not deemed necessary to kill one for that purpose. The carcass, which was already skinned, contained but little blood and was in an emaciated condition. On opening the chest, both lungs were found to be diseased with lobular pneumonia, and presented a spotted appearance, for groups of diseased lobules, surrounded by yet healthy tissue, were partly hepatized and perfectly impervious to air, still presenting their normal structure and merely filled with blood serum or recent and still fluid exudation. The morbid changes, although not limited to any particular portion of either lung, were most developed and most extensive in the anterior lobes, but even in the latter the *interlobular connective tissue was comparatively free from any exudation*. Pleuras and pericardium appeared to be healthy, and no other morbid changes of any consequence could be found.

The examination of the living animals, and still more the *post-mortem* examination of the dead one, proved beyond a doubt that the disease, although very fatal, and, as far as I could learn, confined to the Eastern calves, *is not pleuro-pneumonia, or bovine lung-plague*, but simply a lobular pneumonia, due to want of acclimatization and other external causes.

It may yet be remarked that all the examinations were made in the presence of several witnesses, among whom I will name the owner, Mr. Kennedy, Dr. Brown, of Rozetta, and Hon. James Peterson, of Oquawka.

CHARBON, OR ANTHRAX.—Charles P. Lyman, F. R. C. V. S., writing under date of January 10, 1882, says:

In a letter written to you from London, England, July 26, 1881, and in one from Liverpool, August 15, I called your attention to the fact that Russian wools, &c., were being shipped to this country, and that there existed a danger consequently that the disease known as anthrax, charbon, or, in man, malignant pustule, might be introduced. Although at that time I had never heard of anything that led me to suppose that this disease had been so introduced into this country, upon my arrival here I made certain inquiries, which resulted in the following letter from Mr. T. E. Stone, a copy of which I inclose you.

The following is a copy of the letter alluded to by Dr. Lyman, and is dated Walpole, Mass., December 27, 1881:

Yours of this date received. I cannot tell you how many cases of anthrax (charbon) have occurred at Hyde Park, nor do I believe anyone else can. The superintendent of the factory there and the overseer are both anxious to divert attention from the existence at any time of such a disease, and as there are several physicians there, and only in the extreme local forms is it likely to attract the attention of an inexperienced (in the malady) practitioner, I have no doubt it has been much more frequent than has been generally known. Years ago, when the hair factory was located here in Walpole, I used to see a great many cases of all forms of the malady; and since then, from being acquainted with the men who are operatives here, I have learned of the existence of the disease in New York City, in Pawtucket, Hyde Park, and, in fact, in nearly every place in which the curled-hair business is carried on. I have not known of any epidemic of this disease in Massachusetts among animals, but it has prevailed in Texas and North Carolina. A case occurred in Norwood, Mass., about forty or more years ago, and was described to me by the patient, and the person who contracted the disease at the same time died. Both had skinned a cow that had died on the road. I had two cases last year which occurred in persons employed in a wool-washing establishment in Walpole, and due, probably, to a lot of Persian wool.

Professor Cressy, of the Agricultural College, wrote me a few years ago that the disease had existed among the cows in some parts of Connecticut, and I do not doubt it is somewhat common at times and places; for the average country horse-doctor, who is the one to see such cases, is, so far as I can judge, not very well up in comparative pathology. Although the disease has existed for years in Texas, I found that Dr. Smith, of San Antonio, medical director of that department, did not know of it. I do not know of any official statistics in regard to the disease, but I think there was a commission appointed two or three years ago by the general government to report on certain cattle diseases, but have not had time to keep track of the matter.

Dr. Arthur H. Nichols made a report to the State board of health in 1871. Since that report, I have had, I think, about eight cases, and at the time I wrote the paper quoted by him, I had had from ten to fifteen additional cases, which, for fear of possible errors, I did not include in the report. I have been exceedingly interested in the recent discoveries of M. Pasteur, and had great curiosity to know whether his method of inoculation of a modified virus would act as efficaciously in men as it has done in sheep.

TEXAS CATTLE FEVER.—Mr. S. J. Fletcher, Winchester, Clark County, Missouri, gives the following account of an outbreak of Texas fever among cattle in his neighborhood:

Some years ago Mr. Stours, a neighbor, brought about 200 head of Texas cattle to graze on the prairie near my place. Every animal that came in contact with these cattle, or walked over the ground where they had been, died. At Greorie's Landing, seven miles distant, all the cattle died, although not one of them had been allowed to go among the Texas animals. The Texans were so full of ticks that they literally dropped from them. Mr. Stours was forced to put his cattle into inclosed pastures, where they remained until November. In about three weeks after their removal a Mr. Carscadden put on the same pastures a large number of fattening cattle, after a hard frost. Soon many of these sickened. The remainder were removed, leaving about sixty that showed symptoms of sickness. Of these, fifty-seven died. All the Texans seemed remarkably healthy, and fattened well. I herded my cattle two or three miles distant from them, except one fine Durham heifer which got among them and died in about three weeks, full of ticks.

Mr. George Hatzfeld, of Newton County, Mo., writing on the same subject, says:

We have had many cases of Texas fever in this county. I will only cite a list of losses in township 26, range 30, Newton County, showing the number and value of the cattle lost by this disease.

	Value.
Nich. Krill, 4 cows	$100
A. J. Buzzard, 14 fattening cattle	210
T. Bradley, 2 cows	50
S. Blevins, 2 cows	50
J. Gilman, 2 cows	50
John Price, 3 fattening cattle	65
G. Baker, 4 fattening cattle	95
J. Hewitt, 6 cows	150
N. N. Kaufman, 3 cows	75
Total, 39 cattle	$820

This is about an average of losses through the whole county.

TUBERCULOSIS.—Dr. R. Jennings, of Detroit, Mich., says in regard to this disease, and his method of treating it:

We have at least two herds of cattle in this State affected by tuberculous disease, the result or termination of bronchial pneumonia. These herds are distant from each other about forty or fifty miles. In each the disease began in the bull, and spread gradually among both herds, leaving little doubt as to its contagious nature. It appeared on both farms at about the same time. I was called to see both herds last July (1881). In October following one of the bulls was killed and an autopsy made by non-professionals, which satisfied the owner (from his reading upon the subject) that pleuro-pneumonia prevailed among his stock. His description of the pathological changes were at variance with those of pleuro-pneumonia, as there was no hepatization, or any indication of it in any portion of the lung. I convinced him of the error, and requested him to send me portions of the diseased structures for examination, in the event of his losing any more of his herd.

On the 23d of November following I received parts of the thoracic and abdominal viscera, all of which were in a tuberculous condition. A brief account of these pathological specimens was given by me in the *Michigan Farmer*, mailed herewith.

In the treatment of this disease in cattle I have recommended, as a test of their virtue, the hypophosphites of lime and soda thus far with apparently good effects. The necessary precautions have been taken to guard against the spread of the disease, and also for preventing any unnecessary alarm among the of cattle-breeders of this State.

PRECAUTIONS AGAINST THE SPREAD OF LUNG PLAGUE OF CATTLE.—Since the publication of Special Report No. 34 of this department, Governor Cullom, of Illinois, has issued the following proclamation:

STATE OF ILLINOIS, EXECUTIVE DEPARTMENT,
Springfield, Ill., November 1, 1881.

In pursuance of the act of the general assembly of the State of Illinois, entitled "An act to suppress and prevent the spread of pleuro-pneumonia among cattle," approved May 31, I, Shelby M. Cullom, governor of the State of Illinois, do hereby proclaim that I have good reason to believe that pleuro-pneumonia among cattle has become epidemic in certain localities in the States of Connecticut, New York, Pennsylvania, New Jersey, Delaware, and Maryland, viz., in the county of Fairfield, in the State of Connecticut; in the counties of Putnam, Westchester, Kings, and Queens, in the State of New York; in the counties of Lehigh, Bucks, Berks, Montgomery, Philadelphia, Delaware, Chester, Lancaster, York, Adams, and Cumberland, in the State of Pennsylvania; in the counties of Bergen, Hudson, Morris, Essex, Union, Somerset, Hunterdon, Middlesex, Mercer, Monmouth, Ocean, Burlington, Camden, Gloucester, and Atlantic, in the State of New Jersey; in the county of New Castle, in the State of Delaware; and in the counties of Cecil, Harford, Baltimore, Howard, and Carroll, in the State of Maryland; and I hereby, as required by said act, prohibit the importation of any domestic animals of the bovine species into this State from the aforesaid counties in the States of Connecticut, New York, Pennsylvania, New Jersey, Delaware, and Maryland after the 10th day of November instant, unless accompanied by a certificate of health properly signed by a duly authorized veterinary inspector. Any corporation or individual who shall transport, receive, or convey such prohibited stock shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than $1,000 nor more than $10,000 for each and every offense, and shall be liable for any and all damage or loss that may be sustained by any party or parties by reason of the importation or transportation of such prohibited stock. (Section 4 of act approved May 31, 1881.)

In testimony whereof I hereto set my hand and cause the great seal of the State to be affixed.

Done at the city of Springfield, the day and year above written.

S. M. CULLOM.

By the Governor:

HENRY D. DEMENT, *Secretary of State.*

MORTALITY AMONG LAMBS IN WISCONSIN.—Mr. William Britton, Washburn, Grant County, Wisconsin, furnishes the following description of a disease which has proved quite fatal to a flock of lambs belonging to Mr. J. M. Morris, a neighbor of his:

Mr. J. M. Morris, residing one and a half miles southeast of my residence, had, last fall, twenty-three lambs that were weaned last spring. Late in the fall he noticed that two or three of them had the "scours," and began to treat them for it, sparing neither pains nor expense; but in vain. About the 1st of January they began to die, and up to this date he has lost ten, and this morning showed me two that were dying and another beginning with the symptoms of scours. After these symptoms appear, the "scours" continue for six or eight days. The excrement, smeared over the posterior parts, has the appearance of tar. They eat heartily all this time, and then food is refused; then the animal, after lying down, has not the strength to get up unless assisted, and in about two days it will die. During the entire time, with the exception of the last two days, it looks well and bright about the eyes, with the exception of a slight discharge from the inner cover of a light, mattery color. The liver appears to be in healthy condition; the gall-bladder free of gall, and distended to its utmost with gas or air; a portion of the lungs highly congested and slightly filled with a watery froth, the remaining parts having a healthy and natural appearance. The first stomach is gorged to its greatest capacity with food undigested; no other evidences of disease found in the stomach. Small intestines empty, except that when cut off a very light yellow mucus can be forced from them by stripping through the fingers; the large intestines partly filled with excrement a little thinner than putty, but showing no appearance of a liquid thin enough for the "scours," and all the inside is covered at intervals of a half inch with little sacks the size of a small pea, each filled with a substance looking very much like dry lime.

At death the animals are extremely lean in flesh, and the odor on opening the carcass is very offensive.

None of the other sheep appear to be affected, unless it is shown by the excrement of all of them being discharged at about the consistency of the same from that of a calf. There is no appearance of sheep dung about the pens, and they are all dry-fed. Sanitary surroundings good, feed included.

SWINE PLAGUE IN ARKANSAS.—Mr. F. J. Smith, president of the Independence County Agricultural and Mechanical Association, writes from Batesville, Ark., under recent date, as follows:

One of the greatest evils the farmers of this section are compelled to contend against is what is called hog cholera. On my place, this disease has appeared among my swine three times within four years. The first time I lost 78 hogs; the second 115—including 8 full-blooded sows which cost me $50 each. The disease is now among my hogs for the third time, and up to the present time 10 pork hogs, averaging 300 pounds, 25 shoats, and 2 very fine full-blooded gelts. I have tried many recommended remedies, without success. I attribute the disease in this neighborhood to careless management.

Hogs are neglected and starved. Nearly every fall we have some kind of mast, but that giving out, the animals are left in the woods without anything to eat. They become wormy and lousy.

As an example, two persons near Batesville, about 4 miles from my place, have more than 100 head of hogs running at large, without care of any kind. Nothing is done with the animals that sicken, and the dead are permitted to lie where they die. This has brought the disease to my own farm. While pork was largely exported from this county several years ago, there is not now enough raised to supply the people here. Farmers are discouraged. We have not been clear of cholera for several years. There is only one remedy—a law compelling every owner to put up his hogs as soon as any disease is discovered among them.

The loss sustained by farmers through this disease of cholera is almost incredible. It discourages efforts to improve their stock. I have expended nearly $1,000 for improved and full-blooded hogs, and twice have I lost all on my place; and yet I take extra care of my swine, keeping them well supplied with good spring water and fresh air, changing their beds every night. Each morning I sprinkle lime over the lying-down places, and put a small quantity into the slops. It has proven as satisfactory as any remedy I have tried.

BREEDING AND CARE OF FARM ANIMALS.—Mr. Henry C. Miller, of Westport, Decatur County, Indiana, gives the following good advice regarding the breeding and treatment of farm animals:

Doubtless the extent of losses of farm animals might be lessened by proper care in breeding as well as care and treatment. To secure docility, stamina, and immunity from disease great care should be observed in caring for the horse especially. The vicious habit of breeding blind and broken down wrecks of mares to worthless stallions and originals thin in flesh, deficient in bone and muscle as well as in spirit, is doubtless the cause of two-thirds of the diseases that affect horses. The practice should not only be discountenanced but prevented, if possible, by penal laws enacted by the legislatures of the States. This noble animal should be reared with intent to attain as high a degree of perfection as possible by breeding from none but perfectly sound mares as well as stallions—a large, brilliant eye, well-developed muscle, symmetry of form, and entire exemption from blemish. Much can be done to secure exemption from disease by proper food and grooming.

Cattle have been greatly improved by crossing with Durham bulls. Many of such herds are nearly equal to the Kentucky Shorthorns. Our cattle can, and, doubtless, will, be further improved in this country. Their general health is good. Their sanitary condition may be improved by protection from inclement weather by means of sheds and stabling. The grade of our cattle is kept at a low standard by poor families allowing cows to get with calf by any scrub bull that can serve them rather than patronize blooded bulls at a reasonable charge. I think scrub bulls should be prohibited from running at large by legal enactment. Castration of all such bulls before three months old should be made obligatory.

Loss of hogs still continues from cholera, thumps, quinsey, and many other diseases. It is difficult to counteract any of them. The higher the improvement in stock the more subject to disease, with increased fatality, herds apparently become. When we had the long-nosed "elm-peeler," with long bristles, the diseases that now so fatally affect our hogs were unknown. We cannot think of permitting our hogs to degenerate to the original woods breeds, but by better care and the use of remedies must counteract disease the best we may, and let improvement progress.

ANTHRAX OR CHARBON IN TEXAS.—The symptoms given in the following letter from Mr. R. B. Jarmon, Kerr County, Texas, indicate anthrax, or charbon. A full description of this disease is given in Special Report, No. 34, of this department, to which the attention of the reader is directed. Mr. Jarmon says:

The animal becomes lame in one leg, generally one of its hind legs; ears drooping; eyes a little red and very dull. The animal is averse to moving about, and generally dies in from six to twenty-four hours. After death the leg that was affected is badly bloodshotten; the entire side shows evidence of disease; a bloody substance exudes from its nostrils, and the stomach is dry and parched. The disease is known here as the black-leg, and considered by some to be a kind of murrain. It is very fatal, and confined almost entirely to young stock of from six to eighteen months old. Occasionally, but very seldom, it attacks a two-year old. It has prevailed among the stock here for about four years, and is generally confined to one neighborhood or stock range at a time. When it gets into a herd it is not unusual for from one-fifth to one-third of them to die.

PREVENTIVE FOR SWINE PLAGUE AND FOWL CHOLERA.—Mr. J. Yarborough, of Calhoun County, Mississippi, writes as follows:

In this county we find that *Phytolacca radix* (polk-root) boiled in slop, and given at intervals of two or three weeks, will prevent the appearance of swine plague. Given to fowls in their drinking water, it will also prevent the appearance of fowl cholera.

SWINE PLAGUE IN MICHIGAN.—The disease described below by Mr. Eugene Carpenter, of Grand Rapids, Mich., is the most fatal type of swine plague:

A strange malady has suddenly made its appearance among the hogs owned by two or three farmers in the township of Gaines, in Kent County, Michigan. When the disease manifests itself, large red blotches are observed to appear upon the body of the animal, accompanied by a profuse discharge of blood from the mouth and nostrils; the victim seems to be in intense agony and to experience great difficulty in breathing, and very soon dies.

SWINE PLAGUE IN THE SOUTHWEST.—Mr. Charles C. Robinson, Gum Wood, Sunflower County, Mississippi, gives the following account of the imporation of swine plague into that county:

I have to report the appearance of cholera among the hogs in this immediate vicinity. It was introduced here in the latter part of the winter, or early in the spring, by the introduction here of two Berkshires. Both died, and the disease has spread among the native hogs, which are dying in large numbers. The native hogs have been heretofore nearly wholly exempt. Fancy breeds appear to be more subject to the disease. All the hogs that die (and all die that take it) pass a watery blood from the mouth, nose, and fundament. The hogs that stay in the woods and do not come about the settlements are free from the disease.

SWINE DISEASE IN SOUTH CAROLINA.—Mr. R. J. Donaldson, Georgetown, S. C., writes as follows, under recent date:

I am raising large numbers of hogs, and find this season a disease among them hitherto unknown to me, viz., a loss of power in the loins, from which they gradually die. It is principally among the pigs, but occasionally a brood sow has it. The pigs affected are, for the most part, the best, in fine order, and continue to eat until they die. There are none of the symptoms of ordinary hog-cholera, the disease appearing to be confined to the loins, the animal losing all power in the hind legs. Occasionally it reaches the fore legs when the feet curve in. I have lost hundreds of pigs this season. The pens are in good order and kept clean, and the pigs allowed to run out. I have fed sulphur, charcoal, and sulphate of iron; but those affected seldom recover. The food is rice flour, fed uncooked.

LAUDANUM IN SWINE PLAGUE.—Mr. Danford Hare, Cordington, Morrow County, Ohio, gives the following as his treatment of hogs suffering with the plague:

In regard to treating the swine plague, or fever, I think nothing should be given that will create fever. In the cases I have had I gave gunpowder and cold water first, then laudanum to cause sleep. After this sleep I at once give linseed oil and ammonia. This treatment has been efficient in every case. I think that salt, ashes, black antimony, lime, soap, and turpentine, have a tendency to shorten the life of the hog. If the farmer will open one of his hogs he will find that all medicines used should be to quiet the animal and reduce the fever.

CONTAGIOUS PLEURO-PNEUMONIA IN VIRGINIA.—In reply to a letter of inquiry from the Commissioner of Agriculture, addressed to Dr. Thomas Pollard, Commissioner of Agriculture for the Commonwealth of Virginia, that gentleman, writing under date of September last, says:

I have addressed letters to various prominent cattle-raisers in Virginia, asking for information on this subject, and have received replies from the following gentlemen, viz: Col. Ro. Beverley, "The Plains," Fauquier County; Mr. W. W. Kennon, Sabot Island, Goochland County; Mr. E. S. Woodward, Jonesville, Lee County; Mr. A. M. Bowman, Waynesborough, Augusta County; Mr. Jos. Cloyd, Dublin, Pulaski County; Geo. Johnston, Alexandria; Col. Geo. W. Palmers, Saltville, Washington County; Mr. A. P. Rowe, Fredericksburg; Mr. Seddon Jones, Rapidan, Orange County; Mr. B. W. Dobyns, Hillsville, Carroll County; and Green Farrar, Orange County.

They all, with the exception of Colonel Beverley, say there is no pleuro-pneumonia in their section as far as they know. Colonel Beverley says it prevailed last winter on the dairy farm of Col. Geo. Johnston, near Alexandria. I wrote at once to Colonel Johnston requesting a candid reply as to the existence of the disease on his farm or in his section. He replies there is no disease (pleuro-pneumonia) on his farm or in his section; that the last case he had was in December last, which was treated successfully by his neighbor, Mr. R. F. Roberts, near Alexandria, and who, he says, has had much experience with the disease, and could give me more information in regard to it than any other farmer in that section. I wrote to him, but have failed to receive a reply.

Colonel Beverley also says that pleuro-pneumonia existed eighteen months ago on a farm in Powhatan County, controlled by Mr. W. W. Kennon, being introduced there by a bull imported from England or Maryland, or both. Upon writing to Mr. Kennon he says the disease does not exist on his farm or in his section. We know the disease has prevailed up to last winter around Alexandria for several years, but from the testimony of Colonel Johnson and others we have reason to believe it has been extinguished. The testimony is very emphatic that it prevails in no other section of Virginia.

REPORT OF THE CHEMIST.

SIR: I have the honor to present the following report of the work done by the Chemical Division since the publication of the Annual Report of the Department of 1880.

REPORT OF ANALYTICAL AND OTHER WORK DONE ON SORGHUM AND CORN STALKS BY THE CHEMICAL DIVISION IN 1881-'82.

Varieties of sorghum and maize grown on grounds of the Department of Agriculture, time of planting, and system of cultivation.

For the purpose of continuing the investigation of the several varieties of sorghum and maize, with the view of ascertaining their value as sources of sugar, there were planted upon the department grounds, upon the 29th day of April, 1881, thirty-eight varieties of sorghum, and upon the 30th day of April eight varieties of maize.

The sorghum and maize were planted in drills, the drills being 3 feet apart for the sorghum and 3½ for the maize, and after the plants were about 3 inches high they were thinned out to about 3 inches, and when about 6 inches high they were thinned out so that the sorghum plants averaged from 4 to 5 inches apart, while the maize stalks were about 8 inches apart.

Of the above varieties of sorghum and maize every kind was up May 9, excepting only the sorghum No. 1, the seed of which failed to germinate. This row was replanted May 11, and was up the 16th.

The sorghums were planted upon a rectangular plat about 450 by 110 feet, and the rows of each variety ran lengthwise the plat and in direction east and west.

About half of this plat had been planted in sorghum the previous year; the remainder had been recently broken up by the plow.

Besides the thinning out already mentioned the crop received the usual cultivation given to maize, and, in addition, care was taken to remove the suckers which sprang up from the roots from half of each row of sorghum; the plat being divided into nearly equal portions by a line passing north and south, the suckers being allowed to grow upon the eastern half, and being removed from the western half of the plat.

The analyses of juices given in the pages of this report are from canes selected from the suckered half of each variety of sorghum, unless otherwise mentioned.

A portion of the field in the unsuckered half having been plowed up, that portion was replanted on June 13, and ten varieties were thus replanted. Neither of these varieties planted at this date attained any fair development, but were dwarfed and unhealthy. Reference to this will be made again in this report.

The several varieties of sorghum planted, and the sources whence the seed was obtained, were as follows:

No. 1. Early Amber. Ephraim Link, Greeneville, Tenn.
No. 2. Early Golden. A. B. Swain, Elysian, Minn.
No. 3. White Liberian. Nesbit, Washington, D. C.
No. 4. White Liberian. Rush G. Leaming, Decatur, Nebr.
No. 5. Black Top. D. Wyatt Aiken, Cokesbury, S. C.
No. 6. African. W. E. Parks, Carlisle, Ky.
No. 7. White Mammoth. Amos Carpenter, Carpenter's Store, Mo.
No. 8. Oomseeana. Blymyer Manufacturing Company, Cincinnati, Ohio.
No. 9. Regular Sorgo. Blymyer Manufacturing Company, Cincinnati, Ohio.
No. 10. Link's Hybrid. Ephraim Link. Greeneville, Tenn.
No. 11. Link's Hybrid. Edwin Henry, Greeneville, Tenn.
No. 12. Sugar Cane. Ephraim Link, Greeneville, Tenn.
No. 13. Goose Neck. P. P. Ramsey, Belgrade, Mo.
No. 14. Bear Tail. Jacob Latshaw, Cedarville, Ill.
No. 15. Iowa Red Top. Jacob Latshaw, Cedarville, Ill.
No. 16. New Variety. F. W. Stump, Marshall, Ill.
No. 17. Early Orange. I. A. Hedges, Saint Louis, Mo.
No. 18. Early Orange. H. F. D. Daganhardt, Piqua, Ohio.
No. 19. Orange Cane. J. G. Fitzgerald, Brookston, Tex.
No. 20. Neeazana. Blymyer Manufacturing Company, Cincinnati, Ohio.
No. 21. Wolf Tail. Ephraim Link, Greeneville, Tenn.
No. 22. Gray Top. H. C. Sealey, Columbia, Tenn.
No. 23. Liberian. Blymyer Manufacturing Company, Cincinnati, Ohio.
No. 24. Mastodon. D. Wyatt Aiken, Cokesbury, S. C.
No. 25. Honduras. Ephraim Link, Greeneville, Tenn.
No. 26. Sugar Cane. C. E. Miller, Effingham, Ill.
No. 27. Hybrid. Will N. Wallis, Collin County, Texas.
No. 28. White Imphee. John N. Barger, Lovilia, Iowa.
No. 29. Goose Neck. G. N. Gibson, Shelbyville, Ky.
No. 30. White African. John N. Barger, Lovilia, Iowa.
No. 31. West India Sugar Cane. D. C. Snow, Lamoille, Iowa.
No. 32. Sugar Cane. John N. Barger, Lovilia, Iowa.
No. 33. New Variety. John N. Barger, Lovilia, Iowa.
No. 34. Minnesota Early Amber. Vilmorin, Paris.
No. 35. Holcus Saccharatus. Vilmorin, Paris.
No. 36. Holcus Sorghum. Vilmorin, Paris.
No. 37. Holcus Cernus, White. Vilmorin, Paris.
No. 38. Honey Cane. J. H. Clark, Pleasant Hill, La.

In Nos. 5 and 6 there were present in each row two well-defined varieties, and the results of the analyses were kept distinct, and will be found tabulated as No. 5 "tall" and No. 6 "short," these being regarded as other than the Black Top or African.

It will be observed that in the above list twelve States are represented as furnishing seed, and four varieties were obtained from France, among which is our own Early Amber, which already appears to be grown there from seed imported from America. It is interesting also to observe that although some thirty years since we obtained our Chinese varieties of sorghum from France, and at the present time we have many of these varieties extensively cultivated in the United

States, that nearly if not every variety of these Chinese sorghums appears to have disappeared in France, since the large house of Vilmorin & Co. were unable to send even a single specimen.

The local names of the above mentioned varieties, as, for example, Nos. 12, 26, 31, and 32, must not be confounded with the real sugar cane of Cuba and Louisiana, for the so-called sugar canes represented by the above numbers are only varieties of sorghum, a family of plants quite distinct from the true sugar cane.

The varieties of maize planted were as follows:

No. 1. Egyptian Sugar Corn.
No. 2. Lindsay's Horse Tooth.
No. 3. Blount's Prolific.
No. 4. Improved Prolific Bread.
No. 5. Broad White Flat Dent.
No. 6. Long Narrow White Dent.
No. 7. Chester County Mammoth.
No. 8. 18-rowed Yellow Dent.

Each of the above varieties were planted in plats having ten rows, 24 feet in each row, and the rows 3½ feet apart. There was, therefore, of each variety planted $\frac{1}{52}$ of an acre, or 840 square feet.

There was also planted, about May 15, on grounds which had been hired for the purpose, as follows:

At Mr. Golden's, about one mile from Uniontown, forty-four varieties of sorghum, in small lots, amounting in all to 13 acres. These varieties were chiefly the same as those grown upon the grounds of the department. There was also grown by him 3 acres of the Liberian and 12 acres of the Honduras. Owing to the excessive drought, thirteen of the small lots failed to germinate, and these were replanted June 1 and 2.

There was also planted upon the grounds of Mr. Carlisle Patterson, just beyond the city limits, some 65 acres of Early Amber and of Link's Hybrid, and, owing to the backward season and the ravages of the wire and cut worms, this plat was replanted three times, the last planting being completed June 18.

There was also planted upon the grounds of Dr. Dean, about one mile from Benning's Bridge, 12 acres in Honduras, 10 acres in Neeazana, 10 acres in Early Orange, 12 acres in Liberian, and 6 acres in the eight varieties of maize planted upon the department grounds. The sorghums were planted by May 23, and the maize by May 25.

Dr. Dean began replanting Honduras June 2, Early Orange June 7, Liberian June 9, Neeazana June 13. Dr. Dean begun second replanting Honduras June 18, Early Orange June 20, Liberian June 21, Neeazana June 29.

During the early part of the season a careful record was kept showing the development of the several varieties of sorghum and maize grown upon the grounds of the department, since, as has already been shown in our previous investigations, so much depends upon the condition of the sorghum in reference to the production of sugar or even of sirup. It is, of course, more than probable that in other localities, and in other seasons, the rapidity of development would be greater or less than in the case of these, and in order that every circumstance calculated to throw light upon the results of our examinations of these sorghums and corn stalks may be given, the following table is appended, in which may be found the height and developments of the several varieties at different periods during the season.

It will be remembered that No. 1 Early Amber was planted twelve days later than the others.

Development of sorghum and maize in height and stages.

Number of row.	Variety.	Height of stalks.										Stage.	Stages of development attained at different periods.														
		June 22.		July 7.		July 26.		July 30.		Aug. 19.		Aug. 19.	July 5.	July 10.	July 15.	July 20.	July 25.	July 30.	Aug. 4.	Aug. 9.	Aug. 12.	Aug. 19.	Aug. 25.	Sept. 2.	Sept. 11.	Sept. 18.	Sept. 24.
		Ft.	in.	Ft.	in.	Ft.	in.	Ft.	in.	Ft.	in.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
1	Early Amber	1	6	4	0	8	0	8	0	8	6	15	1	2	4	7	8	10	11	12	13	15	16	17	18	19	....
2	Early Golden	3	4	5	9	8	8	8	8	8	9	15	2	4	6	7	8	10	11	12	13	15	16	17	18	19	....
3	White Liberian	3	0	6	2	8	6	8	6	8	6	15	2	4	6	7	8	10	11	12	13	15	16	17	18	19	....
4	White Liberian	3	4	6	4	8	6	8	6	8	6	15	2	3	6	7	8	10	11	12	13	15	16	17	18	19	....
5	Black Top	3	0	5	10	6	0	6	6	6	6	15	2	3	5	9	10	11	12	....	13	15	16	17	18	19	....
6	Affican	2	8	5	2	6	0	7	0	8	0	13	2	3	4	8	9	10	11	....	12	14	15	17	18	18	19
7	White Mammoth	2	0	4	6	8	0	8	0	9	9	17	3	4	4	5	5	....	6	....	7	8	9	12	14	15	17
8	Oomseeana	2	6	5	8	8	6	8	0	8	0	14	2	3	6	8	9	10	11	....	12	14	15	17	18	18	....
9	Regular Sorgho	2	9	6	2	9	6	9	6	9	6	14	2	3	5	8	9	10	11	....	12	14	15	17	18	19	....
10	Link's Hybrid	2	3	5	6	9	6	9	6	11	0	12	....	....	1	2	4	8	9	....	10	12	13	15	16	17	18
11	Link's Hybrid	2	0	5	4	9	6	10	0	11	3	12	....	....	1	2	3	6	7	....	10	12	13	14	16	17	18
12	Sugar Cane	2	3	5	6	9	6	9	9	11	0	13	....	....	1	3	4	7	8	....	10	13	14	16	18	....	19
13	Goose Neck	2	6	5	10	9	0	9	0	9	6	13	1	2	4	7	8	10	....	11	12	13	14	17	18	....	19
14	Bear Tail	2	9	6	4	8	6	8	6	9	0	14	2	3	7	9	....	10	....	11	12	14	15	17	18	....	19
15	Iowa Red Top	2	8	5	10	8	0	8	6	9	0	14	1	3	5	8	....	9	10	11	12	14	15	17	18	....	19
16	New Variety, Stump	2	6	5	8	9	0	9	0	9	6	14	1	3	6	9	10	11	....	12	13	14	15	17	18	....	19
17	Early Orange	2	0	5	0	8	3	8	6	9	6	11	....	....	1	3	4	6	7	8	9	11	12	14	16	17	18
18	Early Orange	2	0	4	0	8	8	8	3	9	0	10	....	....	1	3	4	6	7	8	9	10	12	14	15	16	17
19	Orange Cane	2	4	4	8	8	4	8	4	9	0	11	....	....	2	4	6	7	8	9	10	11	13	15	16	....	....
20	Neeazana	2	8	5	2	7	6	7	6	7	9	11	....	1	3	7	8	9	....	10	....	11	....	....	....	....	....
21	Wolf Tail	2	3	5	2	8	6	9	0	11	0	10	....	1	....	2	2	3	4	5	7	10	....	....	....	....	....
22	Gray Top	1	9	4	2	7	3	7	6	9	0	10	....	....	....	....	1	2	3	5	6	10	....	....	....	....	....
23	Liberian	1	9	4	4	7	6	7	9	9	6	9	....	....	....	....	1	3	4	5	6	9	....	....	....	....	....
24	Mastodon	2	4	4	8	8	6	9	6	11	0	8	....	....	1	1	2	3	4	5	6	8	....	....	....	....	....
25	Honduras	1	10	4	0	7	6	8	6	11	0	6	....	....	....	....	....	1	2	3	4	6	....	....	....	....	....
26	Sugar Cane	2	6	4	10	7	0	7	0	7	6	14	1	3	6	8	9	10	11	12	13	14	....	....	....	....	....
27	Hybrid No. 4	2	6	5	10	9	0	9	0	9	0	13	1	2	5	7	8	10	....	11	12	13	....	....	....	....	....
28	White Imphee	1	8	4	0	7	10	8	3	8	6	10	....	....	1	3	4	6	7	8	8	10	....	....	....	....	....
29	Goose Neck	1	6	4	2	8	6	8	6	9	0	12	....	....	1	3	4	7	8	9	9	11	....	....	....	....	....
30	White African	2	3	5	0	8	0	8	0	8	6	14	1	2	4	7	8	10	11	12	13	....	....	....	....	....	....
31	West Indian Sugar Cane	1	8	4	4	7	0	7	6	8	6	9	....	....	....	....	1	2	4	5	6	9	....	....	....	....	....
32	Sugar Cane	2	6	5	4	7	0	7	0	7	6	12	1	3	5	8	....	9	....	....	....	....	....	....	....	....	....
33	New Variety, X Lib. and Oom	2	0	4	8	6	3	6	3	6	6	14	1	3	5	7	8	9	....	....	....	....	....	....	....	....	....
34	Minnesota Early Amber	2	9	5	3	8	0	8	0	9	0	15	1	3	5	9	....	....	....	....	....	....	....	....	....	....	....
35	Holcus Saccharatus	2	3	5	4	8	6	8	6	10	0	9	....	....	2	3	4	5	....	....	....	9	....	....	....	....	....
36	Holcus Sorghum	3	0	5	6	10	6	10	6	11	0	8	....	....	2	4	6	7	....	....	....	8	....	....	....	....	....
37	Holcus Cernuus, White	2	8	5	0	9	3	9	3	9	6	9	....	....	2	....	3	6	....	....	8	9	....	....	....	....	....
38	Honey Cane	2	0	4	8	8	6	8	9	12	0	7	....	....	1	....	....	2	....	3	4	7	....	....	....	....	....

5. T.	Black Top, tall	....		....		....	10	0	11	6	7	....	....	....	....	....	....	....	....		7	9	11	13	14	....
6. S.	African, short	....		....		....	6	0	6	6	13	2	3	4	8	9	10	...	11	12	14	15	17	....	18	19
1	Egyptian Sugar Corn	3	6	6	0	....	9	0	9	6	15	3	4	6	9	10	11	12	13	14	15	....	....	....	....	....
2	Lindsay's Horse Tooth	4	6	6	6	....	10	0	10	0	14	3	4	5	8	9	10	11	12	13	14	....	....	....	....	....
3	Blount's Prolific	4	6	6	8	....	11	0	11	0	15	1	2	4	7	8	10	11	12	14	15	....	....	....	....	....
4	Improved Prolific Bread	3	9	6	4	....	11	0	11	0	15	....	....	2	6	7	9	11	....	12	15	....	....	....	....	....
5	Broad White Flat Dent	3	9	6	6	....	10	6	10	6	14	....	....	2	6	7	8	10	....	11	14	....	....	....	....	....
6	Long Narrow White Dent	3	3	6	0	....	9	6	9	9	14	....	....	1	5	6	8	10	....	11	14	....	....	....	....	....
7	Chester County Mammoth	3	8	6	2	....	6	6	8	0	17	1	2	6	9	10	12	14	....	15	17	....	....	....	....	....
8	18-rowed Yellow, Dent	3	8	5	6	....	8	9	8	9	11	....	....	2	6	7	....	8	....	9	11	....	....	....	....	....

Development of sorghum and maize on Department grounds.

Number of row.	Variety.	Panicle not swelling.				Panicle just swelling.				Panicle just appearing.		Panicle one-third out.			Panicle two-thirds out.			Panicle fully out.				In blossom.	
		July 11.	July 16.	July 20.	July 26.	July 11.	July 16.	July 20.	July 26.	July 7.	July 11.	July 11.	July 20.	July 26.	July 11.	July 16.	July 26.	July 11.	July 16.	July 20.	July 26.	July 16.	July 20.
1	Early Amber										x					x				x			
2	Early Golden									x								x				x	
3	White Liberian									x								x				x	
4	White Liberian									x								x				x	
5	Black Top									x					x							x	
6	African									x											x	x	
7	White Mammoth	x	x	x	x				x														
8	Oomseeana									x					x					x		x	
9	Regular Sorgho									x					x						x	x	
10	Link's Hybrid	x	x	x	x		x														x		
11	Link's Hybrid	x	x	x	x		x										x						
12	Sugar Cane	x	x	x	x		x										x						
13	Goose Neck									x		x									x	x	
14	Bear Tail									x					x						x	x	
15	Iowa Red Top									x		x									x	x	
16	New Variety, Stump									x		x								x		x	
17	Early Orange	x	x	x	x	x								x									
18	Early Orange	x	x	x	x			x						x									
19	Orange Cane	x	x	x	x		x														x		
20	Neeazana					x										x					x		x
21	Wolf Tail	x	x	x	x			x															
22	Gray Top	x	x	x	x				x														
23	Liberian	x	x	x	x				x														
24	Mastodon	x	x	x										x									
25	Honduras	x	x	x	x																		x
26	Sugar Cane														x						x	x	
27	Hybrid No. 4										x										x	x	
28	White Imphee	x	x	x	x			x									x						
29	Goose Neck	x	x	x	x			x									x						
30	White African										x								x				x
31	West Indian Sugar Cane	x	x	x	x				x														
32	Sugar Cane									x		x									x	x	
33	New Variety, X Lib. and Oom										x										x	x	
34	Minnesota Early Amber									x								x				x	
35	Holcus Saccharatus	x	x	x	x		x				x												
36	Holcus Sorghum	x	x	x	x		x													x			
37	Holcus Cernuus, White	x	x	x	x		x						x								x		
38	Honey Cane	x	x	x	x									x									

		Not tasseled.		Half tasseled.		All tasseled.		Tassel and silk.		Ears forming.													
		July 11.	July 16.	July 11.	July 16.	July 20.		July 11.	July 16.	July 16.	July 20.												
1	Egyptian Sugar Corn							x		x													
2	Lindsay's Horse Tooth			x					x														
3	Blount's Prolific			x					x														
4	Improved Prolific Bread	x			x	x																	
5	Broad White Flat Dent	x			x	x																	
6	Long Narrow White Dent	x			x	x																	
7	Chester County Mammoth							x			x												
8	18-rowed Yellow Dent		x			x																	

EXPLANATION OF THE STAGES OF GROWTH OR OF DEVELOPMENT AS USED IN THIS REPORT.

In order to record as closely as was possible the development of the plants at the time when they were taken from the field for examination, a series of numbers were made use of, which indicated the several stages of development. The determination of stages after the 14th was in the case of the sorghum difficult, and depended upon the increasing hardness of the seed. These numbers and their significations are as follows:

Stages of development in maize and sorghum for 1881.

Stage.	Maize.	Sorghum.
1	About one week before opening of panicle....	About one week before opening of panicle.
2	Immediately before opening of panicle	Immediately before opening of panicle.
3	Panicle just appearing..........................	Panicle just appearing.
4	Panicle two-thirds out..........................	Panicle two-thirds out.
5	Panicle entirely out; no stem above upper leaf.	Panicle entirely out; no stem above upper leaf.
6	Panicle beginning to bloom at the top	Panicle beginning to bloom at the top.
7	Ear just appearing..............................	Flowers all out; stamens beginning to drop.
8	Ear larger	Seed well set.
9	Ear larger still..................................	Seed entering the milk state.
10	Ear larger still..................................	Seed becoming doughy.
11	Ear in roasting condition	Seed doughy; becoming dry.
12	½ week after reaching roasting condition.....	Seed almost dry; easily crushed.
13	1 week after reaching roasting condition.....	Seed dry; easily split.
14	1½ weeks after reaching roasting condition....	Seed split with difficulty.
15	2 weeks after reaching roasting condition....	Seed split with more difficulty.
16	2½ weeks after reaching roasting condition....	Seed split with still more difficulty.
17	3 weeks after reaching roasting condition....	Seed harder.
18	3½ weeks after reaching roasting condition....	Seed still harder.
19	4 weeks after reaching roasting condition....	Seed still harder.
20	4½ weeks after reaching roasting condition....	Seed still harder.
1 W.	1 week after ear had been picked in stage 11.	
2 W.	2 weeks after ear had been picked in stage 11.	
3 W.	3 weeks after ear had been picked in stage 11.	
4 W.	4 weeks after ear had been picked in stage 11.	
5 W.	5 weeks after ear had been picked in stage 11.	
6 W.	6 weeks after ear had been picked in stage 11.	
7 W.	7 weeks after ear had been picked in stage 11.	
8 W.	8 weeks after ear had been picked in stage 11.	

From the preceding table it will be seen that on July 26, fifty-seven days after planting, nearly every variety of sorghum was in blossom, and had, so far as size, attained its maximum development, since their average height was about 8½ feet.

A preliminary examination of one variety of sorghum and two of the varieties of maize was made June 13, when the plants were about two feet high, and it was found that even at this early period there was in their juices an appreciable amount of both sucrose and glucose, as will be seen by the following results:

Juice of White Liberian Sorghum: sucrose, .12 per cent.; glucose, .63 per cent.

Juice of Egyptian Sugar Corn: sucrose, .25 per cent.; glucose, .94 per cent.

Juice of Lindsay's Horse Tooth Corn; sucrose, .38 per cent.; glucose, .98 per cent.

From the above it would seem that both forms of sugar exist in these plants even in this early stage of development, and that the relative proportion of the two remains about the same for a long time, as will be seen by reference to the tables which follow. It has, however, not been demonstrated that what is given in the above analyses as sucrose is such beyond question. It was, however, if not sucrose, at least a substance not precipitated by sub-acetate of lead solution, and without action upon Fehling's solution, until, like sucrose, it had been acted upon by a dilute acid solution. It remains, however, a matter rather of importance in its relation to vegetable physiology than of practical value as regards the production of sugar from these plants.

ANALYSES OF EACH VARIETY OF SORGHUM AND MAIZE.

The following tables show the results of the analyses of each variety of sorghum and maize stalks made during the season; the date of each analysis, the dimensions and weight of the stalk, the percentage of juice obtained from the stalk and the specific gravity of the juice, the per cent. of sucrose, glucose, and of the solids not sucrose nor glucose present in the juice. In addition, there is given the percentage of surcrose present as determined by the polariscope, which will be found to correspond closely with the percentages of sucrose as determined by analysis.

EARLY AMBER.

CARLL & GARDNER.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
8	June 27	....	9	2.0	.8	......	......	55.80	1.014	1.25	.07	1.91	....
11	July 5	....	6	2.8	.6	3.5	2.7	56.44	1.017	2.21	.70	......	....
175	July 16	1	1	5.	.6	.8	.6	53.69	1.028	3.15	1.15	2.65	....
176	July 16	2	1	5.5	.6	.8	.6	63.29	1.026	2.92	1.52	1.45	....
76	July 11	3	2	5.	.7	1.4	1.1	70.85	1.021	2.20	.58	4.10	....
135	July 14	4	1	5.5	.8	.9	.7	62.50	1.026	2.96	1.32	......	....
164	July 15	4	1	7.5	.9	1.3	.9	66.26	1.028	2.60	.30	3.50	....
165	July 15	5	1	8.5	1.1	1.9	1.1	63.80	1.023	2.61	.99	2.80	....
250	July 20	6	1	7.5	.7	1.1	.9	68.28	1.047	3.17	3.10	2.42	....
332	July 23	7	1	8.	.6	.96	.8	65.79	1.041	3.54	4.83	3.63	....
333	July 23	8	1	7.7	.6	1.02	.8	65.81	1.036	3.57	3.53	3.27	....
361	July 25	9	1	7.4	.7	1.1	.9	62.68	1.040	2.68	7.33	2.47	7.02
360	July 25	9	1	6.5	.8	1.0	.8	69.48	1.047	2.75	7.12	2.54	7.25
411	July 28	9	2	7.5	.7	1.8	1.4	67.23	1.053	2.87	8.41	1.87	7.96
441	July 29	10	2	7.2	.6	2.0	1.8	60.00	1.058	3.02	9.02	2.75	9.18
452	July 29	10	....	......	......	......	......	....	1.057	2.82	9.49	2.87	9.21
501	Aug. 1	11	2	8.	.6	1.7	1.5	64.66	1.066	2.47	12.25	2.87	11.39
578	Aug. 8	12	1	7.8	.6	1.1	.9	63.37	1.072	1.86	12.96	5.04	12.82
664	Aug. 13	13	1	8.0	.6	1.0	.8	64.51	1.071	1.57	14.27	3.30	13.89
760	Aug. 18	14	1	7.8	.7	1.3	1.0	63.59	1.083	1.55	14.83	3.93	....
819	Aug. 24	15	2	8.0	.6	1.9	1.4	56.10	1.083	.98	16.47	2.91	....
850	Aug 26	15	1	7.4	.7	1.4	.9	63.25	1.080	.76	15.48	3.06	....
886	Aug. 27	15	1	9.4	.7	1.4	1.0	56.01	1.091	1.11	16.18	7.42?	....
942	Aug. 31	16	2	8.5	.6	1.7	1.3	52.77	1.091	1.09	18.43	3.27	....
1004	Sept. 3	17	1	7.5	.7	1.4	1.0	52.88	1.091	.80	18.61	6.81?	....
1059	Sept. 7	17	2	8.5	.8	2.9	2.1	54.17	1.089	.80	18.23	3.00	16.92?
1118	Sept. 10	18	2	9.5	.5	2.1	1.6	49.91	1.089	1.26	17.55	4.15	....
1230	Sept. 17	18	1	9.2	.6	1.1	.8	43.83	1.088	.86	17.09	3.64	....
1367	Oct. 5	After 18	1	9.0	.7	1.3	.8	54.28	1.078	.87	15.24	2.76	....
1513	Oct. 15	...do	2	8.0	.7	1.7	1.3	57.90	1.078	1.16	14.82	4.60	13.96
1568	Oct. 22	..do	1	7.3	.5	1.1	.7	56.13	1.076	1.27	14.28	3.50	17.01
1617	Oct. 27	...do	1	7.5	.8	1.1	.8	56.90	1.083	.92	15.76	4.18	....
1640	Oct. 29	...do	2	8.0	.5	2.2	1.5	57.82	1.077	.89	12.65	5.77	14.76
1674	Nov. 2	...do	2	8.3	.5	1.9	1.8	61.98	1.074	1.23	13.91	3.24	....
1705	Nov. 4	...do	2	7.3	.6	1.8	1.1	59.96	1.069	1.02	12.50	3.41	12.76
1735	Nov. 7	...do	2	8.4	.8	1.7	1.2	50.00	1.076	.83	14.01	3.51	14.03
1769	Nov. 9	...do	1	9.0	.6	1.1	.9	54.52	1.074	.89	13.82	3.72	13.97
1799	Nov. 12	...do	1	8.0	.8	1.0	.8	48.85	1.077	.82	14.00	3.84	13.86
1828	Nov. 15	...do	1	7.2	.6	1.0	.7	55.42	1.073	.95	14.27	2.20	14.09
1857	Nov. 17	...do	1	5.7	.8	1.1	.8	53.96	1.075	1.46	13.03	4.25	....

EARLY GOLDEN.

A. B. Swain.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
15	July 6	1	2	6.3	.8	2.2	1.8	66.99	1.026	3.11	2.91	.90	....
177	July 16	2	1	6.8	.7	1.1	1.	69.68	1.027	3.10	1.36	2.40	....
58	July 8	3	2	7.5	.9	2.4	2.	71.33	1.023	3.17	1.58	2.16	....
95	July 12	4	1	7.5	.7	1.4	1.3	63.89	1.020	3.02	2.53	1.95	....
166	July 15	4	1	9.	1.2	3.5	2.6	70.17	1.015	1.91	.56	2.06	....
96	July 12	5	1	7.7	.7	1.4	1.1	69.22	1.028	3.22	2.76	2.48	....
167	July 15	5	1	8.8	1.1	2.3	1.6	68.49	1.020	2.03	.62	5.78	....
136	July 14	6	1	9.	.8	1.2	1.0	68.01	1.036	2.95	4.04	3.67	....
221	July 18	7	1	8.	.6	1.1	.8	66.39	1.040	3.00	5.25	1.17	....
251	July 19	8	1	8.5	.8	1.7	1.4	69.57	1.046	2.97	5.42	1.17	....
334	July 23	9	1	8.5	.7	1.4	1.1	64.43	1.045	2.75	6.54	5.06	....
352	July 25	9	1	8.6	.8	1.3	1.1	69.40	1.049	2.56	7.83	2.26	7.[illegible]
412	July 28	9	1	8.2	.8	1.4	1.2	67.53	1.064	2.05	11.43	2.26	11.41
437	July 29	9	......	......	......	......	......	......	1.063	2.17	11.75	1.84	11.[illegible]
442	July 29	10	1	8.9	.7	1.3	1.1	66.47	1.067	2.57	12.71	1.68	11.44
390	July 26	10	1	7.8	.7	1.0	.9	67.43	1.054	2.39	9.57	1.51	[illegible]
502	Aug. 1	11	2	8.3	.7	2.7	2.5	64.26	1.072	1.76	13.84	2.91	13.[illegible]
579	Aug. 8	12	1	9.5	.7	1.6	1.3	60.76	1.075	1.33	14.64	4.96	14.[illegible]
666	Aug. 13	13	1	9.0	.7	1.4	1.0	64.31	1.078	1.16	14.57	4.02	....
761	Aug. 19	14	1	8.0	.8	1.4	1.1	58.50	1.077	1.60	14.48	2.67	....
820	Aug. 24	15	1	9.0	.7	1.5	1.2	61.56	1.080	1.64	14.37	3.08	....
852	Aug. 26	15	1	7.6	.8	1.4	1.1	56.05	1.083	1.06	15.90	3.44	....
889	Aug. 27	15	1	9.0	.8	1.5	1.1	59.80	1.084	1.96	15.82	4.49	....
943	Aug. 31	16	1	8.6	.3	1.1	.8	63.42	1.090	1.26	18.08†	3.73	....
1005	Sept. 3	17	1	8.2	.8	1.3	.9	56.21	1.088	.97	17.89	6.73†	16.[illegible]
1060	Sept. 7	17	1	9.2	.8	1.4	1.2	58.86	1.084	.81	17.41	2.76	....
1119	Sept. 10	18	1	8.8	.8	1.7	1.2	55.37	1.081	1.56	16.10	2.57	....
1221	Sept. 17	18	1	9.7	.8	1.6	1.1	52.80	1.085	1.11	16.89	3.19	....
1368	Oct. 5	After 18	1	7.8	.7	1.1	.7	51.18	1.073	1.39	13.56	2.15	....
1514	Oct. 15	...do	1	8.5	.8	1.4	1.0	57.93	1.075	1.18	14.12	4.14	....
1569	Oct. 22	...do	1	9.0	.7	1.5	1.0	58.78	1.085	1.03	16.11	3.86	....
1608	Oct. 27	...do	1	9.5	.9	1.6	1.2	54.16	1.087	.81	16.97	2.56	14.[illegible]
1641	Oct. 29	...do	1	8.9	.7	1.1	1.0	60.44	1.076	1.15	14.45	3.54	....
1676	Nov. 2	...do	1	8.6	.7	1.0	.8	47.88	1.072	1.46	11.78	4.90	....
1706	Nov. 4	...do	1	8.3	.7	1.4	1.1	58.59	1.078	.99	14.54	3.30	14.4[illegible]
1736	Nov. 7	...do	1	9.0	.7	1.2	.9	57.59	1.067	1.75	11.57	3.17	11.4[illegible]
1770	Nov. 9	...do	1	9.0	.7	1.5	1.0	53.45	1.073	1.24	13.39	4.53	....
1800	Nov. 12	...do	1	8.5	.7	.9	.8	56.08	1.078	1.01	14.00	3.83	13.9[illegible]
1829	Nov. 15	...do	1	9.0	.7	1.0	.9	55.38	1.077	1.16	14.66	2.56	14.[illegible]
1858	Nov. 17	...do	1	9.0	.8	1.2	1.0	55.45	1.076	1.48	13.31	4.34	....

WHITE LIBERIAN.

Mr. Nesbit.

16	July 6	....	2	6.5	.9	2.6	2.1	68.00	1.020	2.88	4.31	....	....
178	July 16	1	1	6.0	.7	.8	.6	64.29	1.024	2.96	1.20	.60	....
179	July 16	2	1	6.0	.6	.7	.5	72.31	1.027	3.08	1.76	2.21	....
59	July 8	3	1	6.7	.9	1.4	1.2	72.03	1.024	3.29	1.04	2.18	....
80	July 11	3	2	6.5	.7	2.1	1.7	71.21	1.023	2.91	.74	2.82	....
81	July 11	4	2	7.4	.8	2.7	2.2	67.30	1.026	2.98	1.43	1.24	....
168	July 15	4	1	8.0	1.1	2.2	1.4	63.39	1.024	2.51	.97	2.86	....
97	July 12	5	1	7.3	.8	1.3	1.1	71.25	1.027	3.13	1.99	5.10	....
169	July 15	5	1	9.0	1.0	2.1	1.2	58.86	1.022	1.83	1.59	3.96	....
137	July 14	6	1	9.0	.9	1.4	1.2	72.78	1.032	3.21	2.85	2.66	....
222	July 18	7	1	9.3	.7	1.4	1.2	72.07	1.042	3.03	5.21	1.35	....
252	July 19	8	1	8.0	.8	1.6	1.3	72.61	1.041	3.01	5.63	5.04	....
335	July 23	9	1	8.0	.8	1.5	1.3	60.03	1.053	3.68	7.57	4.51	....
353	July 25	9	1	7.8	.8	1.3	1.0	71.11	1.051	2.43	8.06	2.82	[illegible]
444	July 29	10	1	8.0	.7	1.3	1.0	69.40	1.065	2.38	11.34	2.25	10.[illegible]
503	Aug. 1	11	2	8.0	.6	2.7	2.3	64.02	1.073	1.49	14.39	3.36	13.86
580	Aug. 8	12	1	8.5	.8	1.8	1.5	65.79	1.076	1.84	14.64	4.74	14.[illegible]
667	Aug. 13	13	1	8.0	.7	1.5	1.2	62.18	1.082	.92	16.90	3.15	16.1[illegible]
762	Aug. 19	14	1	8.8	.8	1.5	1.2	61.94	1.080	1.31	15.15	3.26	14.25
821	Aug. 24	15	1	8.5	.8	1.6	1.2	57.95	1.086	1.03	17.38	2.86	16.93
853	Aug. 26	15	1	8.8	.9	1.7	1.4	58.52	1.088	.88	17.66	3.73	....

WHITE LIBERIAN—Continued.

Mr. Nesbit—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
892	Aug. 29	16	1	7.8	.9	1.8	1.3	62.24	1.083	1.06	17.41	2.76	....
944	Aug. 31	16	1	7.9	.8	1.6	1.1	58.94	1.089	.96	17.88	3.78	....
1006	Sept. 3	17	1	7.5	.8	1.4	1.0	58.12	1.082	1.09	16.74	6.75?	15.98
1061	Sept. 7	17	1	7.9	.9	1.5	1.1	68.51	1.087	.86	18.30	1.77	....
1120	Sept. 10	18	1	8.5	.9	2.2	1.8	59.70	1.078	1.18	15.77	3.22	....
1222	Sept. 17	18	1	8.0	.7	1.1	.8	53.72	1.086	1.05	16.88	2.88	....
1369	Oct. 5	After 18	1	7.1	.7	1.0	.7	44.54	1.087	1.08	16.32	2.74	....
1515	Oct. 15	....do ...	1	7.5	.9	1.1	.9	55.81	1.088	1.09	16.59	5.11	....
1570	Oct. 22	....do ...	1	7.5	.7	1.0	.8	61.68	1.070	1.81	12.38	3.52	....
1609	Oct. 27	....do ...	1	7.3	.9	1.1	1.0	52.19	1.089	1.14	17.99	2.81	16.27
1642	Oct. 29	....do ...	1	7.7	.6	.9	.8	59.75	1.077	1.09	14.62	3.92	....
1677	Nov. 2	....do ...	1	9.3	.7	1.5	1.2	57.11	1.083	.91	16.16	3.70	....
1707	Nov. 4	....do ...	1	8.3	.8	1.5	1.1	50.17	1.080	.97	15.02	3.68	15.09
1737	Nov. 7	....do ...	1	8.8	.7	1.1	1.0	55.83	1.083	1.05	15.26	3.77	....
1771	Nov. 9	....do ...	1	7.8	.6	.9	.6	51.41	1.052	2.04	6.45	5.29	....
1801	Nov. 12	....do ...	1	7.2	.8	.8	.7	55.23	1.088	.71	15.14	4.55	15.87
1830	Nov. 15	....do ...	1	8.5	.7	1.1	.9	50.72	1.075	1.10	13.41	4.42	....
1850	Nov. 17	....do ...	1	8.8	.7	1.1	.9	56.31	1.068	1.54	11.63	3.63	....

WHITE LIBERIAN.

Rush G. Leaming.

1	June 13	....	7	2.0	.7	......	......	85.30	1.017	.68	.12	2.40	....
4	June 20	....	7	2.5	.7	......	......	60.30	1.016	1.19	.34	1.62	....
7	June 27	....	5	3.4	1.0	......	......	70.00	1.017	2.01	.10	1.78	....
180	July 16	1	1	6.	.5	.6	.5	72.92	1.027	4.46	.46	1.40	....
12	July 5	2	3	4.8	.8	3.8	3.0	68.56	1.024	3.29	.34	1.90	....
77	July 11	2	2	6.8	.8	1.7	1.4	70.40	1.027	3.32	1.06	2.09	....
82	July 11	3	2	5.5	.8	2.0	1.6	70.41	1.025	2.80	1.55	3.25	....
84	July 11	4	1	8.	.8	1.5	1.2	74.14	1.021	3.18	1.25	9.82	....
85	July 11	5	1	8.5	.5	1.6	1.4	72.82	1.028	3.25	1.98	4.15	....
138	July 14	6	1	7.7	.7	2.7	1.8	69.23	1.038	3.15	4.09	.99	....
223	July 18	7	1	9.4	.8	1.5	1.3	60.33	1.047	2.84	6.94	1.25	....
253	July 19	8	1	8.5	.8	1.5	1.2	71.88	1.036	2.98	7.15	3.38	....
336	July 23	9	1	8.6	.8	1.5	1.2	68.21	1.054	2.78	9.03	4.96	....
391	July 27	10	1	8.5	.8	1.8	1.1	65.79	1.062	2.48	11.02	1.56	10.67
504	Aug. 1	11	2	8.3	.7	2.2	2.0	63.75	1.073	1.63	14.60	1.85	13.53
581	Aug. 8	12	1	8.3	.8	1.6	1.4	63.22	1.075	1.57	14.86	3.99	14.22
668	Aug. 13	13	1	8.0	.7	1.2	1.0	62.58	1.072	1.34	16.35	1.43	....
763	Aug. 19	14	1	8.2	.8	1.5	1.1	65.43	1.082	1.30	16.50	2.21	15.72
822	Aug. 24	15	1	8.6	.8	1.6	1.2	62.81	1.085	1.11	17.44	2.37	....
854	Aug. 26	15	1	8.5	.8	1.6	1.2	61.24	1.086	.97	17.58	2.03	16.97
893	Aug. 29	16	1	8.3	.9	1.5	1.2	58.90	1.079	1.35	15.49	1.41	14.56
945	Aug. 31	16	1	8.7	.7	1.4	1.0	53.84	1.089	1.10	18.03?	3.55	....
1007	Sept. 3	17	1	8.0	.6	.9	.7	54.92	1.091	.91	18.02	7.29?	....
1062	Sept. 7	17	1	7.8	.7	1.2	1.0	59.51	1.095	.95	19.58	2.75	....
1123	Sept. 12	18	1	7.5	.6	1.0	.7	56.72	1.090	1.26	17.32	2.93	....
1223	Sept. 17	18	1	8.5	.8	1.3	1.0	50.54	1.080	1.27	15.24	3.86	....
1370	Oct. 5	After 18	1	7.4	.7	.8	.6	55.10	1.068	1.11	11.85	3.05	....
1516	Oct. 15	....do ...	1	9.0	.8	......	1.2	55.80	1.082	1.27	16.24	4.20	....
1571	Oct. 22	....do ...	1	9.0	.7	1.3	1.1	59.61	1.080	1.09	15.12	4.25	....
1610	Oct. 27	....do ...	1	8.5	.6	1.1	.8	50.00	1.082	1.31	15.32	3.88	14.81
1643	Oct. 29	....do ...	1	8.7	.8	1.2	1.0	57.68	1.071	1.42	12.72	3.81?	....
1678	Nov. 2	....do ...	1	8.9	.9	1.9	1.5	65.00	1.062	2.17	9.79	3.71	9.15
1708	Nov. 4	....do ...	1	8.9	.8	.9	.8	52.21	1.073	1.51	12.57	4.32	....
1738	Nov. 7	....do ...	1	9.3	.7	1.1	.9	51.06	1.074	1.63	12.89	4.28	....
1772	Nov. 9	....do ...	1	9.3	.8	1.4	1.0	52.23	1.071	1.43	12.72	4.80	....
1802	Nov. 12	....do ...	1	8.8	.9	1.2	1.0	58.33	1.077	.90	14.24	3.94	14.47
1831	Nov. 15	....do ...	1	9.0	.7	1.0	.8	53.83	1.085	.63	15.60	4.09	15.98
1860	Nov. 17	....do ...	1	7.4	.9	.7	.6	61.99	1.065	3.04	9.84	3.77	9.26

BLACK TOP.

D. W. Aiken.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
181	July 16	1	1	6.5	.8	1.1	.9	67.35	1.030	2.06	2.72	3.61	....
17	July 6	2	2	7.5	1.	3.0	2.4	66.60	1.020	2.00	1.13	2.65	....
63	July 9	3	1	6.3	1.	1.3	1.0	67.33	1.023	3.05	.49	1.56	....
86	July 11	3	1	5.8	.9	1.5	1.	73.68	1.029	1.79	3.89	6.55	....
98	July 12	4	1	6.	1.	1.4	1.1	70.49	1.028	3.52	1.47	4.10	....
140	July 14	5	1	6.8	1.	1.6	1.3	71.89	1.032	3.30	2.34	3.23	....
139	July 14	6	1	6.5	.7	.8	.6	71.48	1.033	3.81	2.45	3.45	....
224	July 18	7	1	7.	.8	1.2	.9	70.23	1.042	4.53	3.41	.50	....
254	July 19	8	1	4.6	.7	.9	.6	65.45	1.044	2.45	6.41	3.20	....
255	July 19	9	1	5.5	.6	1.0	.7	67.27	1.045	1.89	7.20	2.50	....
413	July 28	9	1	6.0	.8	1.5	1.0	69.45	1.061	3.96	9.55	1.91	9.66
436	July 29	9	......	......	......	......	......	....	1.060	4.21	9.27	2.00	8.94
337	July 28	10	1	5.6	.8	1.2	.9	78.48	1.044	2.63	6.25	3.86	....
582	Aug. 8	11	1	5.5	.8	1.3	.9	68.54	1.049	1.15	9.21	3.46	8.12
609	Aug. 13	12	1	7.5	.8	1.8	1.3	63.77	1.061	3.41	10.07	2.30	9.44
764	Aug. 19	13	1	6.8	.8	1.4	1.0	68.00	1.077	.73	15.17	2.94	....
823	Aug. 24	14	2	7.1	.7	2.0	1.5	58.56	1.085	1.15	15.32	4.28	16.33
855	Aug. 26	14	1	7.1	.6	1.0	.8	66.08	1.079	1.21	15.47	1.77	15.07
894	Aug. 29	15	1	6.2	.8	1.1	.8	59.56	1.087	.46	17.06	4.44	....
946	Aug. 31	16	1	7.6	.7	1.0	.8	58.94	1.091	.99	19.20?	3.09	....
1008	Sept. 3	17	1	6.7	.8	1.0	.8	58.90	1.085	.63	17.03	7.22?	....
1063	Sept. 7	17	2	6.5	.7	1.5	1.1	64.45	1.074	2.03	14.08	2.32	....
1124	Sept. 12	18	1	7.5	.8	1.2	.9	63.98	1.067	2.49	11.21	.12	....
1224	Sept. 17	18	1	6.8	.8	.9	.7	50.46	1.086	.49	17.01	2.96	....
1371	Oct. 5	After 18	1	9.5	1.0	2.0	1.2	51.31	1.068	.70	12.58	2.40	11.75
1517	Oct. 15	....do	1	12.0	1.1	3.0	2.2	57.44	1.078	.40	14.65	5.03	....
1572	Oct. 22	....do	1	8.5	1.1	2.2	1.7	66.03	1.074	2.38	12.11	4.22	....
1611	Oct. 27	....do	1	12.0	.9	2.2	1.7	59.81	1.068	.50	12.96	3.37	11.49
1644	Oct. 31	....do	1	10.7	1.1	3.5	2.1	53.79	1.069	.47	12.35	4.43	....
1679	Nov. 2	....do	1	8.9	.6	1.4	1.0	61.81	1.072	2.18	12.80	3.53	12.33
1709	Nov. 4	....do	1	11.0	1.2	3.0	2.2	51.58	1.070	.44	11.87	4.27	....
1739	Nov. 7	....do	1	12.0	1.1	2.9	1.9	55.86	1.072	.44	12.88	4.08	12.96
1773	Nov. 9	....do	1	12.4	1.2	2.9	2.0	50.66	1.069	.37	12.24	4.32	12.66
1803	Nov. 12	....do	1	10.2	1.0	1.5	1.0	47.51	1.056	.44	8.57	4.20	....
1832	Nov. 15	....do	1	11.0	1.3	2.2	1.6	51.87	1.061	.70	10.07	3.60	....
1861	Nov. 17	....do	1	8.5	.7	1.0	.8	59.51	1.054	1.89	6.76	4.39	....

BLACK TOP, TALL.

D. W. Aiken.

388	July 26	1	1	9.0	1.1	2.9	2.4	61.06	1.036	1.81	4.09	2.47	....
389	July 26	2	1	8.9	1.3	2.9	2.4	59.16	1.036	1.56	4.95	1.85	....
392	July 27	3	1	9.5	1.1	2.6	2.0	58.89	1.039	1.87	5.66	1.19	....
461	July 30	4	1	10.5	1.3	2.8	2.3	57.88	1.041	1.50	5.49	4.96	5.31
467	July 30	4	......	......	......	......	......	....	1.041	1.50	5.72	4.45	....
518	Aug. 2	4	1	11.6	1.2	3.6	2.8	59.80	1.051	1.55	7.52	1.30	....
462	July 30	5	1	9.8	1.3	3.1	2.4	60.00	1.043	2.25	5.94	4.27	4.40
476	July 30	5	......	......	......	......	......	....	1.043	2.34	5.64	4.29	4.32
553	Aug. 5	6	1	11.4	1.2	3.4	2.8	58.08	1.050	1.19	7.93	4.50	7.75
583	Aug. 8	7	1	10.4	1.3	3.8	2.9	61.14	1.065	1.42	9.45	4.53	9.09
671	Aug. 13	7	1	11.6	1.2	3.6	2.9	53.68	1.065	2.25	10.12	4.30	8.67
766	Aug. 19	8	1	11.6	1.3	4.9	3.5	56.69	1.064	1.30	10.93	2.90	10.27
771	Aug. 19	8	......	......	......	......	......	....	1.064	1.39	12.07	1.58	10.33
825	Aug. 24	9	1	11.4	1.1	3.2	2.8	52.80	1.075	1.08	15.15	2.65	13.41
851	Aug. 26	9	......	......	......	......	......	....	1.078	1.21	13.83	3.14	13.15
856	Aug. 26	9	1	12.2	1.3	4.1	3.3	55.43	1.077	1.21	14.28	2.76	....
904	Aug. 29	10	1	10.7	1.0	2.1	1.5	55.15	1.087	.68	15.75	5.18	....
1009	Sept. 3	11	1	10.0	.9	2.0	1.3	50.41	1.065	.78	11.97	7.34?	....
1132	Sept. 12	13	1	10.2	1.1	2.2	1.4	45.16	1.070	.87	12.27	3.77	....
1225	Sept. 17	14	1	10.8	1.3	3.4	2.7	58.97	1.073	.69	13.28	3.73	....

AFRICAN.

W. E. Parks.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
182	July 16	1	1	7.	1.1	1.9	1.5	68.09	1.027	1.99	2.45	2.91	....
18	July 6	2	2	5.	1.	2.5	1.9	61.42	1.018	1.84	1.28	1.64	....
64	July 9	3	1	6.	.9	1.5	1.1	68.08	1.023	2.29	1.30	5.80	....
87	July 11	3	1	6.5	.7	1.2	.9	66.67	1.026	1.54	2.33	3.17	....
99	July 12	4	1	7.5	.8	1.5	1.2	65.09	1.028	3.10	1.20	3.38	....
141	July 14	5	1	7.3	.8	1.3	1.	69.07	1.030	1.79	3.25	2.77	....
225	July 18	6	1	7.7	.9	1.5	1.3	68.69	1.035	1.99	4.41	1.04	....
256	July 19	7	1	6.5	.7	1.1	.8	69.11	1.046	2.52	6.96	4.86	....
338	July 23	8	1	7.2	.6	.8	.5	66.71	1.047	2.93	5.82	4.62	....
339	July 23	9	1	6.2	.9	1.8	1.4	66.88	1.042	2.78	4.76	4.40	....
354	July 25	10	1	7.4	.6	1.1	.8	65.20	1.051	2.32	7.84	2.80	7.63
554	Aug. 5	11	1	7.5	.8	1.6	1.2	68.83	1.050	3.03	6.52	4.31	7.01
598	Aug. 9	12	1	6.8	.9	1.6	1.2	65.18	1.046	2.92	6.76	1.98	6.26
672	Aug. 13	13	1	8.0	.8	1.9	1.5	63.58	1.068	1.87	11.78	2.73	11.12
767	Aug. 19	14	1	7.9	.9	1.8	1.4	68.12	1.057	2.96	8.31	1.60	....
827	Aug. 24	15	1	7.3	.9	2.4	1.6	65.38	1.062	1.69	15.18	1.47	....
858	Aug. 26	15	1	11.5	1.0	2.2	1.9	58.82	1.090	.87	18.06	2.17	....
895	Aug. 29	16	1	7.7	.8	1.5	1.2	68.26	1.053	2.65	8.57	2.21	....
924	Aug. 31	16	1	9.0	.8	1.8	1.2	61.48	1.082	1.46	15.09	1.66	14.88
947	Aug. 31	16	1	8.2	.7	1.1	.9	56.93	1.091	3.15	16.71	3.00	15.22
1010	Sept. 3	17	1	10.6	.9	1.5	1.2	55.53	1.092	.84	18.33	7.84?	....
1064	Sept. 7	17	1	11.5	1.0	2.2	1.8	45.14	1.098	1.48	18.38	3.95	....
1125	Sept. 12	17	1	11.5	1.1	3.2	2.8	57.46	1.077	1.82	15.70	1.70	14.55
1226	Sept. 17	18	1	10.0	1.2	3.8	3.1	59.30	1.087	.57	17.69	3.12	....
1372	Oct. 5	After 18	1	8.1	.8	1.3	.9	58.06	1.082	.98	15.36	2.98	....
1518	Oct. 15	...do	1	10.5	.9	1.2	1.1	52.07	1.084	3.28	13.97	4.33	....
1590	Oct. 24	...do	1	10.5	.8	1.2	1.0	52.63	1.061	9.07?	2.03?	4.49?	....
1612	Oct. 27	...do	1	8.3	.8	1.1	.8	56.67	1.080	.50	14.51	3.97	13.87
1645	Oct. 31	...do	1	8.0	.9	1.6	1.1	53.84	1.075	.60	13.83	4.71	14.05
1680	Nov. 2	...do	1	10.0	1.0	1.8	1.5	60.85	1.077	.71	14.20	4.58	13.88
1710	Nov. 4	...do	1	7.5	.9	1.3	1.0	72.18?	1.069	1.63	11.28	3.92	11.19
1740	Nov. 7	...do	1	10.8	.8	1.7	1.3	57.86	1.083	.92	15.11	4.33	....
1774	Nov. 9	...do	1	7.7	.8	1.0	.7	62.31	1.056	.54	9.49	3.79	9.59
1804	Nov. 12	...do	1	6.5	.7	.8	.5	53.03	1.067	1.01	10.52	4.25	....
1833	Nov. 15	...do	1	10.0	.7	.7	.5	45.86	1.058	.55	9.09	3.78	....
1862	Nov. 17	...do	1	9.1	1.1	1.3	1.1	60.65	1.066	1.37	10.94	4.01	10.65

AFRICAN, SHORT.

W. E. Parks.

826	Aug. 24	15	....	......	......	......	......	....	1.078	1.39	11.45	6.03	....
828	Aug. 24	15	1	11.0	1.0	2.6	2.2	62.10	1.077	1.21	13.43	4.31	....
850	Aug. 26	15	1	7.8	.8	1.5	1.1	65.13	1.067	.82	12.84	2.03	....
1011	Sept. 3	16	1	7.5	.8	1.0	.8	60.00	1.074	3.49	11.94	6.91?	15.27?
1131	Sept. 12	17	1	7.5	.7	1.1	.9	51.36	1.076	2.70	12.30	3.12	....
1237	Sept. 17	18	1	8.0	.6	1.1	.8	61.05	1.073	1.28	12.12	4.12	....

WHITE MAMMOTH.

Amos Carpenter's Store.

46	July 8	....	2	4.	1.	2.5	2.0	65.67	1.012	1.11	.26	3.17	....
88	July 12	1	1	5.	1.2	1.7	1.4	67.58	1.020	1.81	.49	1.67	....
393	July 27	2	1	7.5	1.1	2.7	2.2	63.62	1.033	2.90	3.56	2.05	3.85
414	July 28	2	1	8.0	1.2	2.6	2.1	67.73	1.034	3.14	3.91	1.67	3.19
463	July 30	3	1	8.0	1.1	2.5	2.0	67.65	1.034	3.39	3.01	4.04	2.93
470	July 30	3	....	......	......	......	......	....	1.034	3.51	3.03	3.80	2.87
556	Aug. 5	4	1	8.5	1.2	2.4	2.0	65.05	1.046	2.71	6.74	3.69	6.96
599	Aug. 9	5	1	9.0	.9	2.0	1.6	69.17	1.050	3.28	7.71	1.87	7.15
600	Aug. 9	6	1	9.3	1.2	2.5	2.0	69.35	1.046	3.52	6.13	2.06	6.02
673	Aug. 13	7	1	8.5	1.0	2.4	1.9	66.47	1.054	2.17	9.55	2.74	8.93
768	Aug. 19	8	1	9.8	1.1	2.5	2.1	70.35	1.066	2.41	12.07	1.32	10.96
829	Aug. 24	9	1	10.0	1.1	2.2	1.9	66.47	1.068	2.45	8.11	6.29	11.75

WHITE MAMMOTH—Continued.

AMOS CARPENTER'S STORE—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
860	Aug. 26	9	1	9.7	1.0	2.2	1.9	65.56	1.072	2.33	12.57	2.36	11.84
896	Aug. 29	10	1	9.7	1.0	2.2	1.9	62.98	1.078	2.02	14.12	1.94	13.60
905	Aug. 29	10	.....	.....	.....	.....	.....	.....	1.080	1.96	14.03	3.87	....
948	Aug. 31	11	1	9.8	1.0	2.2	2.0	65.05	1.078	1.87	16.06	2.61	....
952	Aug. 31	11	.....	.....	.....	.....	.....	.....	1.078	1.89	15.40	2.21	5.07†
1012	Sept. 3	12	1	9.4	1.0	1.9	1.6	35.89	1.085	1.70	15.67	6.73†	....
1017	Sept. 3	12	.....	.....	.....	.....	.....	.....	1.083	1.27	16.53	6.76†	....
1065	Sept. 7	13	1	10.2	1.1	2.4	2.1	62.01	1.083	1.73	16.00	2.40	15.33
1067	Sept. 7	13	.....	.....	.....	.....	.....	.....	1.083	1.78	15.64	2.89	15.14
1126	Sept. 12	14	1	10.2	1.0	2.1	1.9	63.64	1.080	1.62	15.65	1.52	....
1234	Sept. 19	15	1	9.0	1.2	3.0	2.5	58.01	1.087	.82	16.29	7.27†	....
1406	Oct. 7	After 18	1	10.0	1.2	2.3	2.0	59.89	1.082	1.31	14.77	3.65	14.13
1522	Oct. 17	...do	1	10.2	1.2	2.0	1.8	58.13	1.069	1.16	11.99	3.73	....
1581	Oct. 24	...do	1	9.8	.9	1.6	1.2	56.17	1.061	1.81	9.98	3.97	9.54
1613	Oct. 27	...do	1	9.0	.8	.8	.5	47.77	1.059	1.03	7.89	5.48	....
1646	Oct. 31	...do	1	9.5	1.5	3.0	2.3	59.59	1.074	.94	13.09	4.73	13.19
1681	Nov. 2	...do	1	10.0	.5	.9	.8	55.34	1.077	.87	13.51	4.93	....
1711	Nov. 4	...do	1	10.1	1.2	1.3	.9	66.74	1.063	1.43	10.94	3.29	11.18
1741	Nov. 7	...do	1	10.0	1.0	1.6	1.3	58.27	1.074	.58	13.60	4.02	13.36
1775	Nov. 9	...do	1	8.6	.7	1.3	.9	60.51	1.064	.70	10.96	4.45	....
1805	Nov. 12	...do	1	9.7	1.2	1.9	1.7	58.19	1.072	.69	12.49	4.31	....
1834	Nov. 15	...do	1	6.2	.9	1.3	1.2	62.08	1.065	.75	11.44	3.41	11.50
1863	Nov. 17	...do	1	7.8	.7	.7	.6	58.21	1.048	2.50	5.05	4.43	4.52

OOMSEEANA.

BLYMYER & CO.

183	July 18	1	1	7.	1.0	1.9	1.6	70.48	1.027	2.01	2.82	4.58	....
19	July 6	2	2	5.3	.8	2.6	1.9	64.71	1.021	1.90	1.55	1.79	....
65	July 11	3	1	6.5	.8	1.2	.9	66.25	1.023	2.26	.03	3.95	....
89	July 12	3	1	4.8	.8	1.2	.9	56.96	1.023	2.39	1.04	2.23	....
100	July 13	4	1	6.	.6	.9	.7	65.94	1.027	3.43	1.36	2.91	....
142	July 15	5	1	6.8	.9	1.6	1.3	68.15	1.029	1.88	2.86	5.72	....
143	July 15	6	1	6.5	.7	1.0	.8	67.57	1.026	3.47	1.23	2.60	....
226	July 19	7	1	8.5	.8	1.8	1.1	70.82	1.034	4.11	2.18	1.83	....
257	July 20	8	1	9.	.6	1.0	.8	69.00	1.050	1.46	9.38	3.44	....
258	July 20	9	1	7.4	.8	1.4	1.0	70.39	1.048	2.38	7.27	3.27	....
340	July 23	10	1	7.2	.7	1.1	.8	61.05	1.054	.75	9.75	4.67	....
394	July 27	10	2	8.5	.9	3.0	2.4	70.00	1.047	2.35	7.25	1.71	6.73
499	Aug. 1	11	2	7.5	.7	2.8	1.6	66.71	1.039	1.95	5.67	2.38	5.10
001	Aug. 9	12	2	7.0	.6	2.0	1.4	66.18	1.042	3.57	5.49	1.88	5.30
675	Aug. 15	13	1	7.4	.8	1.3	1.1	61.66	1.069	.87	13.17	2.79	12.84
709	Aug. 19	14	1	9.8	.8	1.7	1.4	60.46	1.077	.81	15.33	2.66	....
830	Aug. 24	15	1	9.2	1.0	1.8	1.4	66.29	1.077	2.43	10.23	.42	13.68
862	Aug. 26	15	1	7.7	.9	1.8	1.1	61.52	1.073	1.49	13.74	2.61	....
897	Aug. 29	16	1	8.7	.7	1.2	1.0	62.79	1.089	1.32	17.75	3.33	13.50
949	Aug. 31	16	1	7.2	.7	1.0	.8	64.65	1.070	2.97	13.49	2.04	11.35
1013	Sept. 3	17	1	8.5	.8	1.2	1.0	04.73	1.084	1.60	17.15	5.60†	16.49
1066	Sept. 7	17	1	10.0	.8	1.4	1.2	56.95	1.083	1.07	16.86	2.20	15.42
1127	Sept. 12	18	1	8.5	.7	1.4	1.2	62.21	1.072	2.44	12.56	1.79	12.30
1235	Sept. 19	18	1	8.4	.9	1.7	1.2	56.49	1.085	.53	16.50	7.30†	....
1407	Oct. 7	After 18	1	7.5	.9	.8	.6	48.46	1.048	.95	17.22	2.94	....
1523	Oct. 17	...do	1	8.3	.8	.9	.8	58.94	1.046	8.69	4.11	3.12	....
1582	Oct. 24	...do	1	7.0	.8	.5	.3	41.39	1.025	.69	2.94	3.44	....
1614	Oct. 27	...do	1	9.0	.7	.9	.8	55.23	1.084	2.44	13.88	3.97	12.11
1647	Oct. 31	...do	1	9.5	.7	1.4	1.1	63.32	1.054	2.96	7.70	3.71	7.43
1682	Nov. 2	...do	1	10.3	.7	1.3	1.1	61.64	1.058	2.19	9.22	3.71	8.67
1712	Nov. 4	...do	1	8.5	1.0	1.3	1.0	53.38	1.066	.97	11.00	4.39	....
1742	Nov. 7	...do	2	9.2	.6	1.3	.9	52.21	1.050	1.03	7.17	4.47	....
1776	Nov. 9	...do	1	5.5	.8	.7	.6	60.00	1.037	1.53	8.26	4.46	....

REGULAR SORGHO.

Blymyer & Co.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
184	July 18	1	1	7.	.9	1.5	1.1	71.56	1.025	3.71	......	3.60	......
20	July 6	2	2	5.5	.8	2.5	1.9	64.03	1.020	2.07	.53	2.78	......
66	July 11	3	1	6.5	.8	.9	.7	65.93	......	......	......	......	......
90	July 12	3	1	6.	.9	1.2	.9	71.98	1.022	2.53	1.64	1.26	......
101	July 13	4	1	7.	.9	1.5	1.1	71.57	1.028	1.86	2.43	2.78	......
144	July 15	5	1	7.5	.7	1.0	.7	69.41	1.026	2.92	1.20	1.74	......
145	July 15	6	1	7.3	.7	1.	.7	67.77	1.027	3.53	2.15	2.69	......
227	July 19	7	1	9.5	.8	1.1	.8	56.34	1.046	1.55	5.74	3.22	......
259	July 20	8	1	8.7	.7	1.2	.9	71.19	1.034	2.96	3.42	3.35	......
260	July 20	9	1	7.6	.8	1.3	.9	70.24	1.045	3.14	5.47	2.96	......
341	July 23	10	1	9.7	.7	.9	.7	52.17	1.050	2.56	6.69	4.94	......
395	July 27	10	1	9.5	.8	1.6	1.2	67.52	1.051	3.26	7.59	2.47	7.07
498	Aug. 1	10	2	8.2	.8	2.9	2.2	63.41	1.056	2.63	9.19	2.81	8.62
506	Aug. 2	11	3	9.8	.8	5.3	3.9	65.52	1.054	1.86	8.60	2.87	......
602	Aug. 9	12	1	9.4	.7	1.3	.8	59.88	1.051	1.98	8.29	2.76	7.51
676	Aug. 15	13	1	10.4	.7	1.0	.5	42.14	1.068	1.40	11.56	3.42	......
770	Aug. 19	14	1	9.5	.9	1.7	1.3	62.52	1.061	2.12	10.85	1.58	......
832	Aug. 25	15	1	9.3	.9	2.1	1.8	58.85	1.081	2.24	14.67	2.97	14.83
898	Aug. 29	16	1	10.5	.8	1.2	.9	48.78	1.080	.76	14.88	4.17	......
950	Aug. 31	16	1	9.4	.7	1.2	.9	58.53	1.078	1.48	14.20	4.86	......
1014	Sept. 3	17	1	9.0	.7	1.2	.9	59.29	1.076	1.66	15.09	6.25?	......
1069	Sept. 8	17	1	9.0	.8	1.2	.9	60.94	1.086	1.88	16.99	2.76	16.24
1128	Sept. 12	18	1	9.0	.7	1.4	1.1	62.16	1.063	3.52	10.16	2.07	9.05
1236	Sept. 19	18	1	8.9	.8	1.2	.9	56.01	1.087	.69	16.23	7.45?	......
1408	Oct. 7	After 18	1	10.4	1.0	1.8	1.5	61.19	1.070	2.12	12.54	2.58	......
1524	Oct. 17	...do	1	10.5	.9	1.6	1.3	58.00	1.076	1.85	13.24	3.45	......
1583	Oct. 24	...do	1	9.8	.8	1.0	.7	49.16	1.067	1.54	10.57	4.52	10.00
1615	Oct. 27	...do	1	9.8	.8	1.2	.9	60.14	1.077	1.38	13.69	4.20	13.57
1648	Oct. 31	...do	1	9.0	.9	1.4	1.1	62.50	1.070	1.16	12.85	4.02	12.24
1683	Nov. 2	...do	1	9.0	1.0	1.7	1.4	57.23	1.082	.37	15.80	5.08	......
1713	Nov. 4	...do	1	7.2	.7	1.4	1.0	58.13	1.057	2.82	7.72	4.15	6.49
1743	Nov. 7	...do	1	8.7	.8	1.4	1.0	65.94	1.065	1.43	10.48	3.86	10.45
1777	Nov. 10	...do	1	9.5	.9	......	.9	56.19	1.067	1.28	10.79	3.48	10.24
1806	Nov. 12	...do	1	8.8	.8	1.0	.8	61.71	1.063	1.17	15.55	—1.72?	......
1835	Nov. 15	...do	1	9.0	.7	.8	.6	57.14	1.050	1.34	6.70	4.05	6.71
1864	Nov. 17	...do	1	9.0	.8	1.3	1.1	57.96	1.085	.31	15.45	5.03	......

LINK'S HYBRID.

E. Link.

47	July 8	....	2	5.	1.	2.5	1.9	67.20	1.015	1.68	.79	2.80	......
196	July 18	1	1	6.5	1.	1.7	1.3	67.18	1.025	2.16	2.43	2.72	......
228	July 19	2	1	6.7	1.1	1.9	1.5	67.48	1.033	2.21	3.42	1.53	......
270	July 20	3	1	6.	1.1	2.0	1.6	65.11	1.031	1.88	3.96	2.40	......
342	July 23	4	1	7.8	1.0	2.0	1.5	68.97	1.037	2.19	5.24	5.21	......
448	July 27	4	......	......	......	......	......	......	1.047	2.88	4.00	5.98	7.25
445	July 29	4	1	9.4	1.0	1.8	1.4	67.54	1.047	2.42	7.32	2.67	7.21
355	July 25	5	1	8.4	.9	1.6	1.2	70.54	1.035	2.54	4.09	2.50	3.97
358	July 25	5	1	8.7	.8	1.1	.9	70.19	1.032	2.72	3.79	2.21	3.13
415	July 28	5	1	9.2	.9	1.6	1.3	68.43	1.041	2.73	5.49	2.06	4.95
434	July 29	5	......	......	......	......	......	......	1.040	2.91	5.34	2.08	5.00
464	July 30	6	1	8.7	.8	1.4	1.1	69.43	1.035	3.27	3.78	3.83	2.93
507	Aug. 2	6	3	10.0	.8	4.8	3.8	67.74	1.054	2.21	8.78	2.91	......
556	Aug. 5	7	1	9.2	.9	1.7	1.3	66.77	1.061	1.76	10.87	4.62	11.06
603	Aug. 9	7	1	10.6	.9	1.5	1.2	61.72	1.058	2.26	10.77	1.85	9.66
627	Aug. 11	8	1	9.3	.8	1.4	1.1	69.30	1.058	3.01	9.04	2.69	8.82
677	Aug. 15	9	1	9.5	.8	1.8	1.5	65.40	1.078	1.07	14.74	2.55	14.52
772	Aug. 19	10	1	9.7	1.0	1.8	1.4	64.88	1.071	1.55	13.42	2.60	......
833	Aug. 25	11	1	10.5	.9	1.9	1.6	59.63	1.062	1.69	15.62	2.65	15.53
842	Aug. 25	11	......	......	......	......	......	......	1.083	1.78	16.07	2.69	......
899	Aug. 29	12	1	10.6	.9	1.7	1.5	65.86	1.080	1.50	14.80	3.28	......
951	Aug. 31	13	1	10.4	.8	1.5	1.3	54.30	1.078	1.10	16.85	2.82	......
1015	Sept. 3	14	1	9.3	.9	1.7	1.4	64.09	1.082	1.79	14.94	7.16?	......
1070	Sept. 8	15	1	10.3	.9	1.6	1.3	57.69	1.089	.83	17.86	3.39	......
1129	Sept. 12	16	1	10.5	.9	1.6	1.3	58.33	1.090	.80	18.18	2.85	......
1237	Sept. 19	17	1	10.2	.9	1.8	1.4	52.74	1.092	.34	17.92	7.65?	......
1409	Oct. 7	After 18	1	11.2	1.0	2.0	1.5	58.02	1.090	.51	17.38	4.13	......

LINK'S HYBRID—Continued.

E. Link—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lb.*	*Lb.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
1525	Oct. 17	After 18	1	9.5	1.0	1.8	1.3	54.60	1.085	.40	16.80	3.80	....
1584	Oct. 24	...do	1	10.5	1.0	1.9	1.5	60.36	1.083	.49	15.78	5.33	....
1616	Oct. 27	...do	1	9.8	1.0	1.7	1.4	55.30	1.086	.47	16.06	5.33	15.57
1649	Oct. 31	...do	1	10.0	1.0	1.9	1.4	61.62	1.074	.87	13.46	5.02	12.29
1684	Nov. 2	...do	1	10.6	.8	1.7	1.3	60.81	1.075	.63	13.67	5.04	12.83
1714	Nov. 4	...do	1	10.6	.7	1.5	1.1	55.73	1.079	2.66	12.04	5.18	....
1744	Nov. 7	...do	1	10.2	1.0	2.1	1.6	58.09	1.086	.24	15.43	5.18	....
1778	Nov. 10	...do	1	10.9	1.0	1.8	1.4	58.95	1.082	.26	15.34	4.27	15.15
1807	Nov. 12	...do	1	10.3	.9	1.0	.9	54.89	1.081	.53	14.01	4.93	....
1836	Nov. 15	...do	1	10.5	.9	1.3	1.1	60.58	1.076	.36	13.92	3.88	14.21
1865	Nov. 17	...do	1	10.9	.9	1.6	1.3	56.19	1.082	.55	14.89	5.21	....

LINK'S HYBRID.

Edwin Henry.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
48	July 8	....	1	5.	.7	1.5	1.1	70.69	1.017	1.47	.98	3.19	....
197	July 18	1	1	6.5	1.1	1.6	1.2	72.45	1.025	2.19	2.22	2.51	....
229	July 19	2	1	7.	.9	1.6	1.2	66.00	1.030	2.18	3.04	1.18	....
271	July 20	3	1	7.7	.8	1.7	1.3	68.52	1.033	2.39	4.34	2.14	....
398	July 27	4	1	9.0	.9	1.8	1.4	65.19	1.047	2.89	7.46	1.86	7.17
416	July 28	5	1	9.7	.8	1.7	1.4	67.64	1.049	2.72	7.21	2.22	6.58
439	July 29	5	....	....	....	....	....	....	1.047	2.84	7.05	.71	6.59
465	July 30	6	1	9.7	.9	2.0	1.6	61.69	1.052	2.48	7.90	2.54	7.96
508	Aug. 2	6	2	9.8	.8	3.5	2.8	65.29	1.062	2.15	10.66	3.06	....
557	Aug. 5	7	1	9.1	1.0	1.2	.9	63.72	1.052	2.61	8.01	3.87	7.69
609	Aug. 10	8	1	9.7	.9	1.7	1.3	67.50	1.064	2.70	11.25	1.55	10.65
679	Aug. 15	9	1	11.1	.9	1.7	1.3	63.89	1.069	1.98	12.22	2.54	12.12
765	Aug. 19	10	....	....	....	....	....	....	1.071	2.06	12.79	2.42	12.10
778	Aug. 19	10	1	11.2	1.0	2.0	1.7	64.07	1.071	2.03	12.46	2.78	....
834	Aug. 25	11	1	11.0	.9	1.8	1.5	64.04	1.082	1.69	15.73	2.54	15.14
836	Aug. 25	11	....	....	....	....	....	....	1.082	1.69	15.87	2.64	15.21
909	Aug. 29	12	1	11.1	.9	1.7	1.4	65.11	1.082	1.88	15.58	3.51	....
954	Sept. 1	13	1	10.5	.9	1.6	1.3	63.20	1.082	1.58	16.41	2.43	....
1019	Sept. 5	14	1	11.2	.9	1.7	1.5	62.81	1.089	1.21	18.05	3.28	17.10
1047	Sept. 5	14	....	....	....	....	....	....	1.088	1.55	17.20	3.67	....
1071	Sept. 8	15	1	11.1	.9	1.5	1.3	54.59	1.094	.66	18.86	3.33	....
1130	Sept. 12	16	1	11.0	1.0	1.8	1.5	59.56	1.086	1.03	17.03	2.56	....
1238	Sept. 19	17	1	11.2	.8	1.8	1.4	55.21	1.091	.84	18.28	7.00	....
1410	Oct. 7	After 18	1	11.8	1.1	2.1	1.7	57.25	1.085	.42	16.89	3.38	....
1526	Oct. 17	...do	1	10.5	1.0	1.9	1.5	52.91	1.088	.59	16.13	4.87	....
1585	Oct. 25	...do	1	9.9	1.0	1.8	1.3	58.56	1.080	.42	15.32	3.22	14.75
1618	Oct. 28	...do	1	11.5	.9	1.9	1.4	56.83	1.085	.49	16.22	4.81	....
1650	Oct. 31	...do	1	11.0	1.0	1.6	1.2	54.78	1.074	.44	13.77	5.43	12.69
1685	Nov. 2	...do	1	9.0	.8	1.5	1.1	59.75	1.079	.37	14.92	4.91	15.22
1715	Nov. 4	...do	1	11.3	.7	1.5	1.2	54.32	1.085	.29	15.89	4.55	....
1745	Nov. 7	...do	1	11.0	.9	1.8	1.4	58.93	1.074	.39	13.11	5.12	....
1779	Nov. 10	...do	1	11.2	1.0	1.6	1.3	55.76	1.082	.21	15.36	4.30	15.17
1808	Nov. 12	...do	1	10.4	.9	1.5	1.1	58.18	1.073	.47	12.15	5.27	....
1837	Nov. 15	...do	1	11.0	1.0	1.6	1.5	61.08	1.079	.37	15.14	3.35	15.31
1866	Nov. 17	...do	1	10.9	1.0	1.4	1.0	50.74	1.082	.43	15.68	4.96	15.40

SUGAR CANE.

Ephraim Link.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
49	July 9	....	1	4.5	.6	1.7	1.3	68.06	1.015	1.41	1.21	2.79	....
203	July 18	1	1	6.6	1.	1.9	1.5	68.41	1.026	2.07	2.63	2.70	....
230	July 19	2	1	7.	.9	1.7	1.3	69.48	1.031	2.11	3.24	1.19	....
272	July 20	3	1	7.2	1.1	1.8	1.4	68.08	1.027	2.98	2.94	2.40	....
343	July 23	4	1	8.2	.9	1.6	1.2	71.68	1.037	2.63	4.39	3.97	....
356	July 25	5	1	8.7	1.0	1.6	1.3	71.67	1.033	2.55	8.45	2.80	8.31
417	July 28	5	1	8.7	.8	1.6	1.2	65.48	1.047	2.03	7.59	2.38	7.15
432	July 29	5	....	....	....	....	....	....	1.047	2.34	7.28	2.32	7.23
446	July 29	6	1	9.1	.9	1.7	1.4	71.10	1.046	2.61	6.68	2.73	6.60
455	July 29	6	....	....	....	....	....	....	1.046	2.69	6.16	3.01	6.15

SUGAR CANE—Continued.

EPHRAIM LINK—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
509	Aug. 2	6	3	9.9	.9	4.9	4.0	68.55	1.051	2.43	7.63	2.73	....
466	July 30	7	....	....	....	....	....	....	1.048	2.62	7.02	4.76	6.95
468	July 30	7	1	8.4	.9	1.9	1.5	69.72	1.049	2.55	7.01	6.79	....
558	Aug. 5	8	1	10.0	1.0	2.1	1.7	67.85	1.056	2.24	9.11	4.27	9.20
610	Aug. 10	9	1	9.4	.9	2.1	1.7	75.73	1.071	1.28	13.64	2.12	12.98
680	Aug. 15	10	1	10.1	.8	1.6	1.4	61.81	1.079	1.10	15.14	2.48	14.82
774	Aug. 19	11	1	10.3	1.0	1.9	1.5	62.57	1.075	1.74	14.88	1.98	....
835	Aug. 25	12	1	10.9	1.0	1.9	1.6	60.13	1.082	1.36	15.60	3.01	....
901	Aug. 29	13	1	10.0	.9	1.9	1.6	66.48	1.076	1.56	15.29	3.42	14.21
906	Aug. 29	13	....	....	....	....	....	....	1.076	1.56	15.07	2.60	14.19
955	Sept. 1	14	1	9.6	1.0	1.8	1.4	63.41	1.082	1.27	16.57	2.49	....
1029	Sept. 5	15	1	9.3	.9	1.7	1.4	61.61	1.083	1.09	16.84	3.21	16.86
1072	Sept. 8	16	1	9.8	.9	1.6	1.3	60.83	1.088	.79	16.12	4.87	17.55
1166	Sept. 14	17	1	10.0	.9	1.6	1.8	55.67	1.093	5.14	19.51	.05	....
1239	Sept. 19	18	1	8.9	.9	1.3	1.0	59.17	1.081	.69	15.37	7.06?	....
1461	Oct. 11	After 18	1	10.7	.9	1.6	1.2	58.88	1.084	.57	16.30	3.19	....
1527	Oct. 17	...do	1	10.5	1.0	1.8	1.4	58.93	1.089	.36	16.59	4.85	....
1586	Oct. 25	...do	1	10.2	.9	2.0	1.5	60.14	1.090	.22	....	....	15.63
1619	Oct. 28	...do	1	9.7	1.0	1.8	1.4	60.62	1.078	.53	15.22	3.96	14.28
1651	Oct. 31	...do	1	10.2	.8	1.8	1.2	57.45	1.067	.80	11.88	4.61	....
1686	Nov. 2	...do	1	10.0	.6	1.4	1.0	56.77	1.075	1.17	13.72	4.64	....
1716	Nov. 4	...do	1	10.0	.9	1.7	1.3	58.62	1.081	.26	15.00	4.25	14.76
1746	Nov. 7	...do	1	9.7	.9	1.5	1.1	60.04	1.076	.32	14.43	4.25	14.22
1780	Nov. 10	...do	1	10.0	1.1	1.6	1.2	59.22	1.079	.23	14.74	4.26	14.69
1809	Nov. 12	...do	1	10.3	.7	....	1.1	45.34	1.081	.24	14.54	4.78	14.91
1838	Nov. 15	...do	1	10.0	1.0	1.8	1.4	61.93	1.076	.82	14.30	3.54	14.19
1867	Nov. 17	...do	1	8.8	.7	.9	.8	61.11	1.071	1.40	11.84	4.54	....

GOOSE NECK.

P. P. RAMSEY.

185	July 16	1	1	7.0	.8	1.3	1.0	73.00	1.024	3.62	.14	2.19	....
50	July 8	2	2	6.0	.9	2.4	1.8	60.79	1.019	2.45	.46	2.21	....
91	July 12	3	1	5.8	.9	1.3	1.0	68.96	1.022	2.79	.65	5.46	....
102	July 13	4	1	6.5	.8	1.3	1.0	71.66	1.022	3.15	.55	3.88	....
146	July 15	5	1	7.7	.7	1.2	.9	72.00	1.023	3.25	.51	1.81	....
204	July 18	6	1	6.2	.8	1.3	1.0	72.34	1.032	4.04	1.91	2.28	....
231	July 19	7	1	8.5	.8	1.4	1.0	66.45	1.034	4.23	2.29	.82	....
329	July 22	8	1	6.3	.8	1.3	1.0	72.52	1.039	4.12	4.55	1.62	....
344	July 23	8	1	8.7	.7	1.2	.9	67.42	1.043	4.55	3.87	3.94	....
357	July 25	9	1	8.8	.8	1.5	1.2	70.47	1.039	3.59	3.54	3.19	8.02
418	July 28	9	1	8.7	.8	1.3	.9	66.27	1.056	3.62	7.98	2.88	7.52
497	Aug. 1	10	2	10.0	.8	3.5	2.8	68.81	1.058	3.01	8.84	2.84	8.15
611	Aug. 10	11	1	8.6	.6	1.1	.8	61.24	1.008	1.89	12.98	1.98	....
681	Aug. 15	12	1	8.3	.8	1.5	1.0	65.26	1.062	2.59	10.28	2.14	9.89
775	Aug. 19	13	1	8.6	.8	1.5	1.0	66.88	1.048	4.03	6.70	1.06	5.04
887	Aug. 26	14	1	9.2	.8	1.7	1.2	71.71	1.064	3.53	10.93	1.51	....
902	Aug. 29	15	1	8.3	.8	1.4	1.1	58.83	1.081	1.54	15.93	2.51	....
956	Sept. 1	16	1	9.6	.8	1.4	1.1	56.53	1.066	1.60	15.30	2.28	....
1021	Sept. 5	17	1	10.6	.7	1.2	1.0	53.95	1.083	1.32	16.31	3.28	15.05
1073	Sept. 8	17	1	9.5	.8	1.2	1.0	57.38	1,084	1.81	16.91	3.00	15.99
1167	Sept. 14	18	1	8.5	.8	1.2	1.0	63.01	1.069	1.75	15.70	4.81	....
1240	Sept. 19	18	1	9.0	.9	1.3	1.1	53.54	1.089	.81	16.68	6.38?	....
1462	Oct. 11	After 18	1	9.2	.8	1.1	.8	61.01	1.059	3.57	7.82	2.96	....
1528	Oct. 17	...do	1	9.5	1.0	1.6	1.3	58.09	1.082	1.09	14.99	4.20	....
1587	Oct. 25	...do	1	8.5	.8	1.0	.8	61.91	1.055	2.48	7.31	3.76	6.28
1620	Oct. 28	...do	1	10.0	.6	1.0	.9	57.56	1.069	1.80	11.88	4.14	10.64
1652	Oct. 31	...do	2	10.0	.7	2.5	1.9	58.01	1.072	1.24	13.24	4.08	13.05
1687	Nov. 2	...do	1	8.0	.8	1.4	1.0	56.18	1.076	2.11	13.48	4.06	13.55
1717	Nov. 4	...do	1	11.0	.9	2.7	2.0	55.46	1.075	1.08	13.72	4.03	13.78
1747	Nov. 7	...do	1	8.3	.7	1.1	.9	56.61	1.068	1.22	12.00	4.24	11.28
1781	Nov. 10	...do	1	8.5	.9	1.0	.9	61.82	1.068	1.04	11.83	4.17	10.61
1810	Nov. 12	...do	1	10.5	.9	1.3	1.0	58.20	1.074	.41	13.39	4.77	....
1839	Nov. 15	...do	1	10.0	.6	1.2	1.1	59.00	1.073	1.08	13.12	3.36	13.11
1868	Nov. 17	...do	1	9.1	.9	1.0	.8	56.62	1.068	1.88	11.47	4.48	10.76

BEAR TAIL.

Jacob Latshaw.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
186	July 18	1	1	5.5	.6	.7	.5	67.91	1.028	8.94	.27	1.65	....
21	July 6	2	2	6.8	.9	2.7	2.2	66.11	1.019	3.12	....	2.57	....
45	July 9	3	2	6.5	.8	2.8	2.1	68.93	1.019	2.79	.61	3.22	....
67	July 11	3	1	5.9	.9	1.5	1.2	65.00	1.022	2.44	.23	3.20	....
92	July 12	3	1	6.3	.8	1.2	.9	71.19	1.024	2.65	.42	2.61	....
103	July 13	4	1	7.3	1.0	1.4	1.1	69.43	1.023	3.72	.69	3.56	....
104	July 13	5	1	8.8	.7	1.4	1.1	70.11	1.024	3.65	.87	5.22	....
147	July 15	6	1	8.0	.8	1.5	1.2	67.49	1.028	3.89	.92	2.29	....
174	July 16	7	1	8.3	.9	1.3	1.1	74.02	1.029	3.30	2.12	2.13	....
232	July 19	8	1	7.7	.8	1.2	.9	68.74	1.038	3.83	3.34	.73	....
261	July 20	9	1	8.4	.9	1.4	1.2	68.88	1.040	3.64	4.70	1.51	....
345	July 23	9	1	8.3	.7	1.5	1.2	69.85	1.048	4.05	5.44	4.77	....
360	July 25	9	1	8.8	.9	1.6	1.3	66.03	1.049	3.91	5.72	2.76	6.19
397	July 27	10	1	8.0	.9	1.4	1.2	70.96	1.049	2.69	7.52	1.93	7.20
419	July 28	10	1	8.3	.8	1.3	1.1	65.14	1.051	3.72	6.82	2.21	6.53
448	July 29	10	1	8.3	.8	1.3	1.0	68.50	1.055	2.72	2.49	9.24	6.71
495	Aug. 1	11	2	8.5	.8	2.9	2.4	67.93	1.056	3.94	3.77	7.15	7.86
612	Aug. 10	12	1	8.3	.8	1.4	1.2	64.02	1.070	2.62	12.05	2.15	11.79
682	Aug. 15	13	1	8.3	.8	1.6	1.3	65.51	1.075	2.56	12.99	2.35	12.20
776	Aug. 20	14	1	8.1	1.0	1.6	1.2	58.49	1.069	2.16	12.88	3.29	....
838	Aug. 25	15	1	8.0	.8	1.3	1.0	59.52	1.083	2.44	15.98	1.90	....
903	Aug. 29	16	1	8.2	.8	1.7	1.2	62.25	1.082	2.19	14.39	3.70	....
957	Sept. 1	16	1	8.8	.8	1.5	1.1	62.02	1:088	2.13	10.51	2.08	....
1022	Sept. 5	17	1	8.7	.9	1.6	1.2	57.71	1.086	2.21	16.62	2.80	15.80
1074	Sept. 8	17	1	8.4	.9	1.7	1.3	64.38	1.084	1.90	16.39	3.25	15.90
1168	Sept. 14	18	1	8.5	.8	1.4	.9	52.40	1.087	1.55	17.54	3.77	....
1241	Sept. 19	18	1	9.2	.8	1.5	1.0	56.19	1.082	1.61	15.25	6.29†	....
1463	Oct. 11	After 18	1	8.0	1.0	1.6	1.0	59.13	1.076	2.49	13.37	2.54	....
1529	Oct. 17	...do....	1	8.3	.8	1.3	.8	75.67†	1.076	2.33	12.97	3.93	....
1588	Oct. 25	...do....	1	8.0	.9	1.0	.9	61.38	1.066	3.10	9.85	4.29	9.49
1621	Oct. 28	...do....	1	7.0	.8	.9	.7	59.50	1.067	2.57	9.99	4.82	9.57
1658	Oct. 31	...do....	1	10.6	.7	1.7	1.2	59.13	1.077	.44	14.83	4.64	14.29
1688	Nov. 2	...do....	1	8.3	.9	1.5	1.1	56.32	1.075	1.51	14.03	3.99	13.90
1718	Nov. 4	...do....	1	8.7	1.0	2.1	1.5	57.30	1.085	1.06	15.54	4.55	15.67
1748	Nov. 7	...do....	1	8.0	.9	1.7	1.0	57.69	1.076	1.80	13.09	4.11	13.17
1782	Nov. 10	...do....	1	8.7	.7	1.1	.9	59.17	1.075	1.69	13.30	3.56	12.90
1811	Nov. 12	...do....	1	8.9	.7	.9	.7	62.73	1.068	1.89	8.19	4.23	....
1840	Nov. 15	...do....	1	7.7	1.0	1.0	.8	56.25	1.068	2.04	11.86	3.03	10.90
1869	Nov. 17	...do....	1	8.9	.7	.8	.6	62.09	1.073	1.90	12.53	4.39	12.81

IOWA RED TOP.

J. Latshaw.

187	July 18	1	1	6.5	.8	1.3	1.1	68.27	1.020	2.99	.48	4.12	....
22	July 6	2	2	6.0	.8	2.1	1.6	68.88	1.020	3.19	.58	1.81	....
68	July 11	3	1	6.5	1.0	1.6	1.2	69.73	....	....	....	....	....
93	July 12	3	1	6.3	.8	1.5	1.1	64.42	1.020	2.99	.97	4.52	....
106	July 13	4	1	7.0	.8	1.5	1.1	71.17	1.025	3.05	1.11	3.06	....
105	July 13	5	1	7.5	.9	1.5	1.2	69.63	1.026	3.51	.87	3.41	....
148	July 15	6	1	8.5	.7	1.1	.9	68.89	1.027	4.11	.92	2.52	....
262	July 20	7	1	8.5	.6	1.1	.9	70.79	1.043	3.73	5.28	2.59	....
328	July 22	8	1	8.2	.7	1.1	.9	73.02	1.045	3.01	6.61	2.15	....
346	July 23	8	1	7.0	.8	1.3	1.0	68.88	1.047	2.86	6.96	4.50	....
347	July 23	9	1	8.6	.7	1.4	1.1	70.16	1.044	4.02	5.34	4.33	....
420	July 28	9	1	9.0	.7	1.6	1.2	69.26	1.044	4.11	5.18	2.06	5.30
398	July 27	10	1	9.5	.9	1.9	1.5	70.22	1.058	3.95	7.84	1.83	7.15
510	Aug. 2	10	3	8.8	.7	3.9	3.0	67.05	1.063	1.99	11.51	2.82	....
550	Aug. 5	11	1	8.0	.7	1.3	1.0	68.89	1.061	1.77	11.69	3.31	11.18
614	Aug. 10	12	1	8.6	.7	1.4	1.1	57.60	1.068	1.35	13.72	1.96	11.63
684	Aug. 15	13	1	8.9	.7	1.6	1.2	64.90	1.078	.93	13.83	2.71	14.04
777	Aug. 20	14	1	8.4	.7	1.3	1.0	64.28	1.071	1.08	13.92	3.54	12.29
839	Aug. 25	15	1	8.7	.8	[illegible]	1.2	54.85	1.083	1.13	17.07	1.77	....
907	Aug. 30	16	1	7.9	.6	.9	.6	57.63	1.076	.81	14.72	3.98	....
958	Sept. 1	16	1	8.3	.8	1.4	1.1	54.79	1.087	.92	17.82	3.06	....
1023	Sept. 5	17	1	8.7	.8	1.7	1.2	59.48	1.088	1.51	17.48	2.70	....

IOWA RED TOP—Continued.

J. Latshaw—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
1075	Sept. 8	17	1	11.0	.8	1.6	1.3	58.16	1.087	1.26	16.93	3.88	16.49
1169	Sept. 14	18	1	8.5	.8	1.2	.8	60.10	1.087	.77	18.28	3.94	....
1242	Sept. 19	18	1	8.3	.6	.9	.6	57.76	1.077	1.09	14.51	6.94	....
1464	Oct. 11	After 18	1	9.0	.7	1.3	.9	63.79	1.076	1.51	15.34	1.64	....
1530	Oct. 17	...do	1	8.7	.9	1.3	1.1	44.86	1.075	1.51	13.70	3.48	13.24
1589	Oct. 25	...do	1	8.5	.6	1.4	.9	63.09	1.080	1.35	15.87	2.36	14.77
1622	Oct. 28	...do	1	8.6	.5	1.0	.8	57.06	1.071	1.44	12.72	3.86	12.00
1654	Oct. 31	...do	1	8.1	1.0	1.7	1.2	60.78	1.065	2.03	11.48	3.76	10.99
1689	Nov. 2	...do	1	9.9	.7	1.4	1.1	54.17	1.069	2.23	10.93	4.09	....
1719	Nov. 4	...do	1	9.7	.8	2.0	1.4	60.44	1.078	1.61	14.34	3.85	14.32
1749	Nov. 7	...do	1	8.9	.7	1.4	.9	59.47	1.074	1.79	13.11	4.14	12.95
1783	Nov. 10	...do	1	8.5	.8	1.4	1.0	60.36	1.078	.86	14.25	4.23	14.53
1812	Nov. 12	...do	1	7.6	.8	1.0	.8	53.61	1.066	2.15	9.89	4.14	....
1841	Nov. 15	...do	1	7.8	.7	.9	.7	63.25	1.071	1.22	12.72	3.66	12.65
1870	Nov. 17	...do	1	9.1	.7	1.2	.9	56.89	1.080	1.14	10.12?	9.01?	14.61
1871	Nov. 18	...do	1	8.5	.7	1.1	.8	61.37	1.076	1.33	13.75	3.60	13.47

NEW VARIETY.

F. W. Stump.

23	July 6	1	2	5.5	.8	2.4	1.9	68.48	1.020	3.12	.74	2.21	....
188	July 18	2	1	6.0	.6	.7	.6	70.26	1.025	3.64	.89	4.31	....
69	July 11	3	1	6.5	.9	1.4	1.1	72.40	1.023	3.11	.74	2.74	....
94	July 12	3	1	6.5	.7	1.2	1.0	72.67	1.023	3.06	1.37	3.39	....
107	July 13	4	1	6.7	1.0	1.2	1.0	73.03	1.025	3.29	1.00	3.31	....
108	July 13	5	1	7.0	.9	1.8	1.1	70.95	1.026	3.83	.41	4.73	....
149	July 15	6	1	8.5	.8	1.3	1.1	64.20	1.026	4.32	.81	2.37	....
233	July 19	7	1	8.8	.6	1.1	.9	68.51	1.042	3.63	4.92	......	....
263	July 20	8	1	8.4	.8	1.6	1.3	69.86	1.045	3.88	6.00	2.44	....
273	July 20	9	1	8.4	.6	1.2	.9	69.30	1.042	3.54	5.28	3.08	....
309	July 21	9	1	9.0	.6	1.2	1.0	70.02	1.042	3.36	8.54	......	....
348	July 23	10	1	8.7	.7	1.3	1.1	69.81	1.048	3.11	7.23	4.38	....
387	July 26	10	1	8.6	.7	1.4	1.2	71.59	1.050	3.27	7.39	2.19	6.80
399	July 27	10	1	8.7	.7	1.6	1.3	72.68	1.050	3.29	7.52	2.57	7.46
421	July 28	10	1	8.5	.8	1.8	1.1	69.69	1.058	2.95	9.38	2.79	9.39
450	July 29	10	1	8.2	.7	1.0	.8	71.55	1.056	4.20	7.58	2.82	....
560	Aug. 6	11	1	8.8	.7	1.4	1.2	65.42	1.073	1.61	14.54	3.87	....
615	Aug. 10	12	1	8.1	.8	1.5	1.3	67.07	1.070	2.47	13.06	1.76	13.20
616	Aug. 10	12	1	9.0	.8	1.6	1.4	67.00	1.073	2.23	13.76	1.76	12.38
685	Aug. 15	13	1	8.2	.7	2.0	1.2	61.19	1.082	1.01	17.19	1.62	16.41
778	Aug. 20	14	1	8.6	.8	1.5	1.1	58.41	1.083	1.15	16.40	3.96	16.53
840	Aug. 25	15	1	7.7	.7	1.2	1.0	61.11	1.086	1.65	17.25	2.28	....
908	Aug. 30	16	1	9.0	.8	1.2	1.0	60.25	1.088	1.14	17.46	3.36	17.58
959	Sept. 1	16	1	9.0	.8	1.6	1.2	58.60	1.087	1.09	18.13	2.85	....
1024	Sept. 5	17	1	9.0	.8	1.5	1.2	60.72	1.091	1.51	18.48	2.64	....
1076	Sept. 8	17	1	9.2	.8	1.4	1.2	63.87	1.098	1.26	18.81	2.97	18.70
1170	Sept. 14	18	1	9.0	.9	1.3	1.1	59.00	1.091	1.14	18.61	3.16	....
1243	Sept. 19	18	1	8.1	.7	1.2	.9	55.58	1.089	.78	17.40	5.92?	....
1465	Oct. 11	After 18	1	8.0	.8	1.4	.9	59.39	1.086	1.15	17.18	2.71	....
1531	Oct. 17	...do	1	9.5	.8	1.3	.9	47.38	1.081	1.78	13.90	4.44	....
1590	Oct. 25	...do	1	9.0	.9	1.1	.8	53.72	1.071	2.50	11.11	5.01	9.73
1623	Oct. 28	...do	1	8.6	.7	1.3	1.0	56.68	1.084	.88	15.77	4.56	15.37
1655	Oct. 31	...do	1	8.0	.7	1.3	.9	61.22	1.067	1.85	12.04	3.63	11.76
1675	Nov. 3	...do	1	8.7	.8	1.7	1.2	57.93	1.074	.81	14.70	2.78	13.64
1720	Nov. 5	...do	1	8.5	.8	1.1	1.0	54.48	1.068	1.42	12.25	2.90	11.49
1754	Nov. 8	...do	1	10.0	.6	1.3	1.1	53.24	1.058	1.82	9.33	4.25	....
1784	Nov. 11	...do	1	9.4	.9	1.6	1.2	57.29	1.080	1.04	14.29	3.79	13.95
1813	Nov. 14	...do	1	8.2	.7	1.0	.8	55.00	1.071	1.52	12.19	3.42	12.04
1842	Nov. 16	...do	1	9.0	.7	1.0	.8	56.43	1.073	1.53	12.74	3.76	12.82
1872	Nov. 18	...do	1	9.5	.8	1.0	.7	51.70	1.065	1.98	9.76	4.59	8.97

EARLY ORANGE.

I. A. HEDGES.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
51	July 8	1	1	4.5	.8	1.1	.9	67.81	1.022	2.45	.81	1.87	....
150	July 15	2	1	6.3	.8	1.4	1.1	68.89	1.026	3.65	1.85	2.44	....
234	July 19	3	1	6.0	.9	1.7	1.3	69.15	1.035	4.40	2.11	1.33	....
264	July 20	4	1	7.2	.9	1.4	1.1	70.02	1.035	5.18	2.05	2.53	....
400	July 27	5	1	8.5	.9	1.9	1.5	71.01	1.041	5.83	3.24	1.20	2.17
422	July 28	6	1	8.4	.8	1.5	1.1	68.35	1.050	5.65	4.98	2.42	5.08
512	Aug. 2	6	2	8.5	.8	2.7	2.0	64.69	1.066	4.29	9.73	2.86	....
469	July 30	7	1	8.3	.7	1.4	1.1	68.09	1.052	5.64	5.23	4.76	5.21
617	Aug. 10	8	1	9.2	.8	1.4	1.1	62.72	1.073	5.44	10.69	1.67	12.55
686	Aug. 15	9	1	7.2	.8	1.9	1.2	66.84	1.069	2.98	12.89	1.50	11.91
779	Aug. 20	10	1	10.3	1.0	3.3	2.5	65.89	1.071	3.61	11.88	3.28	11.38
841	Aug. 25	11	1	9.0	.8	1.8	1.4	61.26	1.088	3.33	15.95	2.31	15.41
909	Aug. 30	12	1	8.5	.8	1.5	1.2	58.16	1.091	2.46	17.26	3.19	16.74
960	Sept. 1	13	1	9.2	.8	1.7	1.3	57.82	1.089	2.51	17.68	2.40	....
1025	Sept. 5	14	1	11.3	1.2	3.5	2.9	71.41	1.081	5.78	12.78?	2.34	12.16
1063	Sept. 9	15	1	9.0	.9	1.5	1.3	55.77	1.093	2.29	17.38	4.94	17.89
1171	Sept. 14	16	1	9.0	.8	1.3	1.0	51.49	1.092	1.54	19.20	2.61	....
1250	Sept. 27	18	1	8.1	.7	1.7	1.1	55.84	1.083	1.52	16.57	3.14	....
1477	Oct. 12	After 18	1	9.7	.8	1.9	1.3	61.86	1.083	1.38	15.81	2.52	....
1536	Oct. 18	...do....	1	8.8	.9	1.5	1.0	58.99	1.079	1.64	14.72	2.50	12.92
1591	Oct. 25	...do....	1	7.8	.8	1.2	.8	60.73	1.078	1.86	14.69	3.57	12.99
1624	Oct. 28	...do....	1	10.3	.8	1.6	1.2	51.77	1.077	.58	14.99	4.57	14.51
1656	Oct. 31	...do....	1	8.0	.7	1.8	1.0	58.88	1.072	1.59	13.11	4.23	12.33
1690	Nov. 3	...do....	1	8.5	.7	1.5	1.0	53.76	1.079	.98	14.87	4.11	14.08
1721	Nov. 5	...do....	1	8.0	.9	1.7	1.4	66.30	1.059	1.21	10.54	2.93	10.11
1755	Nov. 8	...do....	1	7.4	.8	1.4	1.2	65.17	1.054	.97	9.68	3.53	8.99
1785	Nov. 11	...do....	1	8.4	.8	1.1	.8	55.52	1.058	1.92	8.22	3.89	7.96
1814	Nov. 14	...do....	1	7.5	.9	1.4	1.1	63.50	1.068	1.05	12.45	3.98	....
1843	Nov. 16	.. do....	1	7.8	.8	1.4	1.3	68.42	1.055	1.38	8.84	3.58	8.44
1873	Nov. 18	...do....	1	9.0	.7	1.4	1.0	57.87	1.081	1.36	14.01	4.51	....

EARLY ORANGE.

H. F. D. DAGANHARDT.

52	July 8	....	2	4.0	1.0	2.5	1.9	64.56	1.017	2.46	.46	3.08	....
235	July 19	1	1	5.5	.8	1.8	1.9	66.38	1.029	4.59	.76	1.01	....
274	July 20	2	1	6.8	.9	1.6	1.2	66.78	1.035	5.25	1.76	3.37	....
361	July 25	3	1	7.4	.7	1.3	1.6	69.43	1.038	5.57	2.89	2.34	1.61
401	July 27	3	1	7.0	.8	1.8	1.0	68.36	1.043	6.44	3.16	1.96	2.56
423	July 28	4	1	8.1	.9	1.6	1.3	67.89	1.050	6.21	4.55	2.99	3.95
447	July 29	5	......	......	......	......	......	....	1.045	5.96	3.84	2.41	....
451	July 29	5	1	9.0	1.0	1.7	1.4	68.09	1.045	5.86	4.04	1.84	....
471	July 30	6	1	8.1	.7	1.4	1.0	66.59	1.051	6.66	3.50	4.87	3.29
513	Aug. 2	6	2	8.6	.8	3.2	2.5	67.22	1.059	5.58	7.44	2.70	....
478	July 30	7	1	8.4	.8	1.6	1.3	66.72	1.051	5.89	4.88	4.76	4.37
618	Aug. 10	8	1	7.6	.7	1.3	1.0	58.69	1.076	4.24	13.31	2.43	12.00
687	Aug. 15	9	1	7.5	.9	1.7	1.2	66.42	1.069	3.91	11.63	1.86	11.21
780	Aug. 20	10	1	8.9	.7	1.2	1.0	62.26	1.083	3.98	13.81	3.63	13.65
843	Aug. 25	11	1	8.7	.8	1.7	1.2	61.98	1.088	2.81	16.54	2.53	16.23
910	Aug. 30	12	1	9.4	.9	1.6	1.3	59.96	1.090	2.81	16.95	2.71	16.57
961	Sept. 1	13	1	8.1	.9	1.5	1.2	58.01	1.091	3.56	16.93	3.34	16.99
1026	Sept. 5	14	1	7.8	.9	1.6	1.2	64.29	1.076	3.70	13.17?	2.64	12.70
1084	Sept. 9	15	1	8.9	.9	1.3	1.0	58.05	1.086	2.58	16.46	3.96	....
1172	Sept. 14	16	1	8.0	.8	1.3	1.0	56.79	1.089	2.85	17.79	3.55	....
1251	Sept. 27	18	1	7.8	.8	1.4	1.0	55.99	1.094	1.39	18.15	4.40	18.63
1478	Oct. 12	After 18	1	9.7	.9	2.0	1.4	58.86	1.088	1.58	16.72	2.70	....
1537	Oct. 18	...do....	1	8.6	.8	1.8	.8	56.95	1.078	1.50	13.55	3.89	12.96
1592	Oct. 25	...do....	1	8.2	.6	1.1	.7	56.00	1.075	1.45	13.10	4.63	....
1625	Oct. 28	...do....	1	9.3	.8	1.9	1.3	58.64	1.087	.88	16.95	4.75	16.58
1657	Oct. 31	...do....	1	8.0	.9	1.5	1.2	65.63	1.063	1.04	11.56	4.44	11.48
1691	Nov. 3	...do....	1	7.3	.8	1.5	1.0	57.67	1.072	.89	13.67	3.30	13.30
1722	Nov. 5	...do....	1	11.0	.8	1.3	.9	46.13	1.064	.47	11.02	4.06	11.07
1756	Nov. 8	...do....	1	9.0	.8	1.9	1.2	55.45	1.077	.84	14.18	4.61	13.94
1786	Nov. 11	...do....	1	7.0	.8	.9	.7	59.70	1.079	.93	14.52	3.59	14.18
1815	Nov. 14	...do....	1	8.5	.7	1.0	.7	53.25	1.082	1.01	14.64	4.08	....
1844	Nov. 16	...do....	1	8.5	.7	.9	.7	55.14	1.071	1.26	12.39	3.99	....
1874	Nov. 18	...do....	1	9.5	.7	1.4	1.1	57.17	1.076	1.21	12.90	4.17	14.11

ORANGE CANE.

FITZGERALD.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
53	July 8	....	2	4.5	.9	2.5	1.9	66.98	1.020	2.94	....	2.01	....
205	July 18	1	1	6.0	.8	1.2	1.0	65.06	1.032	4.91	.37	2.13	....
206	July 18	2	1	6.0	.8	1.5	1.1	68.26	1.029	4.92	.05	2.50	....
236	July 19	3	1	6.5	.8	1.8	1.0	68.51	1.032	4.96	1.13	.84	....
265	July 20	4	1	6.8	.9	1.4	1.1	71.79	1.033	5.26	1.10	2.64	....
275	July 20	5	1	7.3	.8	1.3	.9	71.39	1.032	5.51	1.26	2.19	....
349	July 23	6	1	7.7	.8	1.4	1.1	70.95	1.040	5.06	3.67	3.57	....
402	July 27	7	1	7.7	.6	1.1	.9	68.81	1.053	5.54	6.33	1.90	5.86
515	Aug. 2	8	2	7.5	.8	3.0	2.2	68.94	1.058	4.88	7.85	2.20	....
620	Aug. 10	9	1	7.0	.9	2.0	1.6	65.27	1.069	4.15	12.06	.95	11.22
688	Aug. 15	10	1	7.4	.8	1.8	1.2	65.78	1.073	3.66	12.83	1.68	12.66
781	Aug. 20	11	1	7.8	.8	1.3	1.0	64.17	1.086	3.31	15.22	3.58	15.16
844	Aug. 25	12	1	9.2	.7	1.2	.9	57.44	1.087	3.27	16.84	1.65	15.81
911	Aug. 30	13	1	9.1	.8	1.5	1.2	59.96	1.091	2.97	17.22	2.81	16.87
982	Sept. 1	14	1	8.8	.7	1.0	.8	58.11	1.093	3.43	17.88	2.79	16.41
1027	Sept. 5	15	1	8.0	.8	1.4	1.1	65.38	1.083	3.56	14.12	3.09	14.60
1065	Sept. 9	16	1	9.0	.8	1.3	1.0	54.48	1.089	2.00	17.20	4.67	....
1173	Sept. 14	17	1	7.8	.7	1.1	.9	60.35	1.084	2.06	15.79	4.52	15.13
1262	Sept. 27	18	1	8.9	.7	1.4	.9	49.29	1.089	1.56	16.68	5.17	....
1470	Oct. 12	After 18	1	8.9	.9	1.6	1.1	69.40	1.066	3.51	10.47	2.01	9.78
1506	Oct. 18	...do....	1	8.2	.9	1.4	1.0	58.07	1.081	1.73	14.89	2.98	13.90
1566	Oct. 25	...do....	1	10.0	1.0	2.0	1.3	61.61	1.087	1.01	16.29	4.82	....
1626	Oct. 28	...do....	1	9.8	.6	1.4	.9	51.74	1.081	.99	15.24	4.35	14.71
1658	Oct. 31	...do....	1	9.0	.6	1.7	1.1	57.45	1.077	1.05	14.02	4.80	14.10
1692	Nov. 3	...do....	1	10.5	.9	2.5	1.7	60.59	1.079	1.00	14.96	3.87	14.46
1723	Nov. 5	...do....	1	8.5	.7	1.8	1.3	57.19	1.080	.90	14.86	4.00	14.81
1757	Nov. 8	...do....	1	8.0	.6	1.5	1.2	66.53	1.062	1.24	11.54	3.96	10.90
1787	Nov. 11	...do....	1	11.6	.8	1.5	1.3	59.06	1.072	1.16	12.59	3.92	12.85
1816	Nov. 14	...do....	1	8.0	.8	1.4	.9	57.84	1.077	.99	13.60	4.02	....
1845	Nov. 16	...do....	1	7.0	.7	.7	.6	58.39	1.068	1.81	11.45	4.09	10.99
1875	Nov. 18	...do....	1	8.5	.7	1.2	.9	64.26	1.075	1.41	13.65	3.77	13.98

NEEAZANA.

BLYMYER & CO.

189	July 16	1	1	6.0	.5	.8	.6	62.21	1.026	4.24	....	3.11	....
54	July 8	2	2	4.3	1.0	2.3	1.8	67.07	1.023	3.66	.85	2.82	....
109	July 12	2	1	5.5	.8	1.0	.8	65.79	1.027	4.48	.44	3.35	....
151	July 14	3	1	5.3	.8	1.3	1.0	66.67	1.030	4.55	1.66	2.57	....
207	July 16	4	1	6.5	.8	1.0	.8	70.43	1.036	4.97	1.15	3.71	....
237	July 18	5	1	7.0	.7	1.2	1.0	69.19	1.038	5.48	1.85	.83	....
268	July 19	6	1	7.4	.7	1.1	.9	68.10	1.040	5.84	2.78	2.91	....
276	July 20	7	1	6.8	.6	.9	.7	69.27	1.041	5.58	3.76	2.71	....
350	July 23	8	1	7.0	.7	1.2	.9	69.41	1.052	5.38	6.27	3.46	....
403	July 27	8	1	7.0	.6	.8	.7	69.71	1.052	5.60	5.41	2.35	5.46
424	July 28	9	1	7.2	.7	1.1	.8	70.99	1.054	6.17	5.34	2.77	....
438	July 29	9	......	......	......	......	......	....	1.054	6.22	5.88	1.75	5.36
494	Aug. 1	10	2	7.0	.6	2.0	1.5	64.58	1.064	4.63	9.83	2.44	8.94
621	Aug. 10	11	1	7.0	.6	1.0	.7	60.19	1.076	3.71	13.24	1.45	12.98
689	Aug. 15	12	2	7.0	.6	1.6	1.2	68.70	1.057	4.67	7.59	1.83	7.28
782	Aug. 20	13	1	7.8	.8	1.3	1.0	62.24	1.071	2.12	13.59	2.40	....
846	Aug. 25	14	1	7.4	.7	1.0	.8	61.53	1.065	5.04	10.48	.59	9.03
912	Aug. 30	15	1	7.5	.6	.9	.7	61.96	1.081	3.46	14.50	2.85	14.07
963	Sept. 1	16	1	7.4	.8	1.0	.8	64.84	1.062	5.06	9.05	1.47	8.16
1028	Sept. 5	17	1	10.8	1.0	3.1	2.5	62.78	1.089	4.30	15.35	2.89	15.15
1066	Sept. 9	17	1	7.5	.7	1.0	.7	65.16	1.069	5.90	9.95	3.60	9.09
1174	Sept. 14	18	1	7.1	.6	.8	.6	51.53	1.084	1.96	15.95	4.28	....
1258	Sept. 27	18	1	7.8	.7	.9	.7	46.29	1.080	2.60	14.14	3.67	14.21
1489	Oct. 12	After 18	2	7.0	.7	1.4	1.2	57.03	1.073	2.67	11.26	3.12	....
1580	Oct. 18	...do....	1	7.3	.6	.7	.6	58.51	1.082	1.96	15.25	2.01	13.66
1594	Oct. 25	...do....	1	7.2	.6	.8	.6	60.42	1.058	2.68	8.68	3.10	7.94
1627	Oct. 28	...do....	2	7.2	.6	1.4	1.2	59.70	1.072	1.53	12.22	4.95	11.82
1661	Nov. 1	...do....	2	7.0	.8	1.7	1.8	61.84	1.065	1.43	11.41	3.81	10.72
1696	Nov. 3	...do....	1	11.0	.8	1.3	1.1	60.79	1.076	.40	14.59	3.87	14.49
1724	Nov. 5	...do....	1	9.0	.8	1.7	1.1	60.00	1.074	1.24	13.68	1.18	13.76
1758	Nov. 8	...do....	1	7.3	.7	1.1	.9	61.71	1.063	1.54	11.12	4.22	10.70

NEEAZANA—Continued.

Blymyer & Co.—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
1788	Nov. 11	After 18	1	9.2	1.0	1.5	1.2	64.23	1.072	1.65	11.74	3.72	11.20
1817	Nov. 14	...do....	1	7.0	.7	.7	.6	55.28	1.068	1.52	11.47	3.06	11.20
1846	Nov. 16	...do....	1	10.5	.9	1.1	.9	58.23	1.080	.50	14.58	4.68	14.49
1876	Nov. 18	...do....	1	6.5	.7	.7	.5	60.97	1.070	1.34	14.28	2.18	11.80

WOLF TAIL.

E. Link.

55	July 8	1	1	4.5	1.0	1.4	1.0	58.70	1.010	1.96	1.04	3.37	....
277	July 20	2	1	7.9	.8	1.9	1.5	67.22	1.032	2.64	3.93	2.34	....
404	July 27	3	1	8.0	.8	1.5	1.1	69.23	1.043	3.00	5.62	2.21	5.84
425	July 28	4	1	9.1	.8	2.0	1.6	67.56	1.043	2.69	5.96	2.62	5.92
458	July 29	5	1	9.6	.7	1.3	1.1	67.65	1.049	3.88	6.15	3.12	5.21
516	Aug. 2	5	2	10.1	.8	3.0	2.4	67.78	1.054	3.14	8.11	2.55	....
474	July 30	6	1	10.1	.8	1.6	1.2	68.67	1.053	2.08	7.93	5.75	7.75
561	Aug. 5	7	1	10.3	.8	1.2	1.0	66.00	1.061	2.82	9.62	4.33	9.92
622	Aug. 10	8	1	10.1	.8	1.3	1.1	65.77	1.066	3.16	12.27	.98	10.78
696	Aug. 16	9	1	10.1	.8	1.4	1.1	58.55	1.077	1.99	13.65	2.79	6.43
783	Aug. 20	9	1	10.6	.9	1.5	1.3	74.35	1.065	2.81	12.04	2.05	10.97
846	Aug. 25	10	1	10.7	.8	1.6	1.3	55.92	1.078	2.51	14.69	1.82	....
913	Aug. 30	11	1	10.3	.8	1.2	1.0	59.32	1.086	1.30	16.50	3.20	....
964	Sept. 1	12	1	10.5	.9	1.7	1.4	61.58	1.087	1.55	16.90	3.21	....
974	Sept. 1	12	....	......	......	......	......	....	1.085	1.67	16.96	3.02	....
1029	Sept. 5	13	1	11.0	.9	2.3	2.0	64.82	1.084	3.04	14.41!	3.30	....
1087	Sept. 9	14	1	10.1	.9	1.4	1.1	62.50	1.094	1.53	16.02	6.49!	....
1175	Sept. 14	15	1	10.5	.9	1.4	1.2	59.77	1.090	1.09	18.69	6.59!	....
1254	Sept. 27	18	1	10.2	.8	1.5	1.2	54.09	1.086	1.03	16.55	4.65	....
1326	Oct. 3	After 18	1	10.5	.8	1.3	1.0	53.67	1.085	.94	16.10	4.20	....
1481	Oct. 12	...do....	1	11.2	.9	1.4	1.1	58.75	1.085	1.20	15.60	3.47	....
1540	Oct. 18	...do....	1	11.0	.9	1.4	1.1	59.85	1.083	.51	15.63	3.57	....
1595	Oct. 26	...do....	1	7.0	.6	.8	.7	56.77	1.078	1.68	13.83	3.41	12.87
1628	Oct. 28	...do....	1	11.1	1.0	1.4	1.2	58.45	1.083	.38	15.72	4.95	15.29
1662	Nov. 1	...do....	1	11.4	.6	1.8	1.4	57.55	1.079	.41	14.92	4.17	14.34
1694	Nov. 3	...do....	1	9.0	.8	1.3	1.0	61.93	1.064	1.35	10.78	3.56	10.50
1725	Nov. 5	...do....	1	11.0	.9	1.7	1.5	58.38	1.075	.44	13.41	5.26	....
1759	Nov. 8	...do....	1	11.0	.6	1.4	1.0	57.26	1.080	.42	14.62	6.07	....
1789	Nov. 11	...do....	1	8.7	.9	1.2	1.1	60.61	1.085	.85	15.21	4.48	15.11
1818	Nov. 14	...do....	1	10.5	.9	1.2	1.0	59.86	1.074	.46	13.88	3.44	13.80
1847	Nov. 16	...do....	1	8.8	.8	.8	.7	57.28	1.056	1.90	8.01	4.05	....
1877	Nov. 18	...do....	1	11.0	.9	1.3	1.1	60.69	1.079	.30	14.74	5.07	14.86

GRAY TOP.

H. C. Sealey.

56	July 8	....	2	4.3	1.2	2.8	2.0	66.67	1.015	1.36	.49	2.83	....
208	July 16	1	1	5.0	.9	1.8	1.4	61.46	1.021	3.57	.05	2.40	....
327	July 22	2	1	7.8	.9	1.9	1.5	66.64	1.033	2.57	3.97	1.88	....
405	July 27	3	1	6.9	.8	1.3	1.0	66.67	1.034	4.12	2.73	2.04	2.81
426	July 28	4	1	7.1	.9	1.5	1.2	69.90	1.044	3.19	5.62	2.49	....
431	July 29	4	....	......	......	......	......	....	1.043	3.49	5.21	2.42	5.06
475	July 30	5	1	7.6	.9	1.8	1.3	70.00	1.058	4.21	3.30	3.58	2.94
519	Aug. 2	5	2	8.1	.9	3.1	2.4	65.62	1.057	2.42	9.28	3.23	....
562	Aug. 5	6	1	8.7	.9	1.7	1.3	53.23	1.044	3.88	4.83	3.55	4.65
623	Aug. 10	7	1	8.4	.8	1.3	1.0	66.16	1.049	4.30	6.22	1.58	5.11
697	Aug. 16	8	1	8.2	.8	1.4	1.0	64.46	1.060	3.90	9.18	1.68	7.77
784	Aug. 20	10	1	9.0	.8	2.0	1.6	61.00	1.078	2.72	14.38	2.89	12.28
786	Aug. 22	9	1	9.1	.9	2.1	1.7	76.90	1.065	3.67	10.55	2.21	9.73
795	Aug. 22	9	....	......	......	......	......	....	1.065	3.63	12.15	.51	9.73
863	Aug. 26	11	1	8.8	.9	1.4	1.2	69.65	1.063	4.57	9.65	1.11	....
914	Aug. 30	12	1	9.4	.9	1.5	1.3	68.20	1.075	3.61	12.64	3.05	12.19
973	Sept. 2	13	1	8.2	.9	1.6	1.3	60.16	1.084	1.87	15.97	4.20	14.78
1030	Sept. 5	14	1	11.0	1.2	3.3	2.8	61.71	1.080	3.00	13.86	3.14	....

GRAY TOP—Continued.

H. C. Sealey—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
1048	Sept. 5	14	.....	......	......	......	......	....	1.080	3.00	14.40	3.06	....
1068	Sept. 9	15	1	9.2	.9	1.4	1.2	68.57	1.068	4.62	9.65	4.93	9.42
1181	Sept. 15	16	1	11.5	1.3	3.8	3.3	59.53	1.075	1.98	13.96	5.05	13.56
1256	Sept. 27	18	1	10.3	1.0	2.5	1.9	59.45	1.079	1.83	14.85	3.74	14.41
1327	Oct. 3	After 18	1	8.4	1.0	1.8	1.2	57.97	1.083	1.26	15.78	4.01	....
1492	Oct. 14	...do	1	10.0	1.1	2.6	2.0	65.80	1.069	2.57	12.41	1.81	10.70
1544	Oct. 19	...do	1	9.1	.9	1.2	1.0	57.46	1.070	2.74	10.67	2.66	10.03
1596	Oct. 26	...do	1	10.0	.7	1.2	1.0	57.43	1.086	.57	15.08	4.70	15.09
1629	Oct. 28	...do	1	8.6	.9	.9	.8	60.63	1.067	1.82	10.75	4.72	12.05
1663	Nov. 1	...do	1	10.4	1.4	3.1	2.6	68.44	1.059	1.95	10.02	2.80	9.36
1695	Nov. 3	...do	1	9.0	.8	1.3	1.0	58.44	1.063	2.85	11.75	1.58	9.31
1736	Nov. 5	...do	1	10.5	1.1	2.4	1.8	65.77	1.068	.94	11.98	4.21	11.77
1769	Nov. 8	...do	1	9.7	.8	1.7	1.2	64.95	1.055	1.30	8.93	5.08	8.40
1799	Nov. 11	...do	1	9.0	.9	.9	.7	52.85	1.061	1.47	9.66	3.90	9.19
1819	Nov. 14	...do	1	8.7	1.0	1.0	.8	60.22	1.059	1.28	9.17	3.66	....
1848	Nov. 16	...do	1	8.9	.7	.9	.7	58.01	1.060	3.04	8.06	4.08	7.96
1878	Nov. 18	...do	1	9.0	1.0	1.3	1.1	64.27	1.062	.83	10.22	4.58	10.02

LIBERIAN.

Blymyer & Co.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
57	July 8	....	2	4.3	1.2	3.9	2.5	73.08	1.014	1.92	.28	2.97	....
278	July 20	1	1	6.2	1.0	1.4	1.1	64.43	1.034	4,71	2.41	2.20	....
406	July 27	2	1	6.5	.9	1.7	1.3	64.83	1.039	5.36	3.08	1.81	2.78
427	July 28	3	1	6.8	.8	1.9	1.4	66.92	1.044	5.44	4.14	2.24	3.86
440	July 29	3	.....	......	......	......	......	....	1.044	5.77	3.98	2.08	3.74
528	Aug. 2	4	2	7.8	.8	3.0	2.2	68.43	1.046	6.28	3.27	2.85	....
568	Aug. 6	5	1	8.0	.8	1.4	1.1	59.95	1.050	7.26	4.52	2.81	3.85
628	Aug. 11	6	1	7.4	.8	1.5	1.1	63.05	1.064	6.63	8.82	2.88	7.20
629	Aug. 11	7	1	7.5	.8	1.5	1.1	56.36	1.071	4.37	10.93	3.00	10.78
698	Aug. 16	8	1	8.2	.9	1.7	1.3	66.55	1.073	4.54	11.06	2.58	10.81
785	Aug. 20	9	1	8.5	.8	1.6	1.3	64.63	1.075	4.62	11.99	3.15	11.83
864	Aug. 26	10	1	11.0	1.0	2.5	2.1	67.01	1.070	4.07	11.83	1.29	11.43
915	Aug. 30	11	1	8.5	.7	1.1	1.0	65.97	1.075	5.58	11.66	2.80	10.69
974	Sept. 2	12	1	9.3	1.0	2.0	1.7	63.14	1.078	1.21	15.81	3.01	14.69
1002	Sept. 2	12	.....	......	......	......	......	....	1.077	1.47	15.96	2.80	....
1031	Sept. 5	13	1	10.8	1.0	2.3	2.0	67.77	1.075	6.74?	9.96?	2.27	9.43
1069	Sept. 9	14	1	9.0	.8	1.3	1.1	67.62	1.081	4.71	13.00	3.65	13.19
1182	Sept. 15	15	1	7.3	1.0	2.0	1.7	59.04	1.081	2.94	14.23	4.41	14.81
1256	Sept. 27	18	1	8.0	.7	1.0	.8	54.72	1.083	2.10	16.22	3.10	....
1328	Oct. 3	After 18	1	9.0	.9	1.5	1.2	55.99	1.084	1.72	15.77	4.23	....
1493	Oct. 14	...do	1	9.0	1.0	1.7	1.4	60.34	1.075	3.02	12.44	2.63	....
1545	Oct. 19	...do	1	9.0	1.0	1.6	1.2	55.39	1.076	3.60	11.80	2.76	11.50
1597	Oct. 26	...do	1	9.3	1.0	1.1	.8	57.61	1.071	1.85	10.68	4.71	10.97
1630	Oct. 28	...do	1	8.8	.9	1.6	1.3	58.04	1.076	2.86	12.27	4.99	9.65
1664	Nov. 1	...do	1	9.0	1.0	1.9	1.4	64.91	1.064	2.98	9.59	3.36	9.53
1696	Nov. 3	...do	1	11.0	1.0	2.2	1.7	63.69	1.042	2.69	6.33	1.92	4.62
1727	Nov. 5	...do	1	9.0	.7	1.4	1.1	60.00	1.069	2.79	11.15	3.68	11.46
1761	Nov. 8	...do	1	9.0	.7	1.8	.9	59.01	1.066	2.60	10.29	5.16	9.97
1791	Nov. 11	...do	1	11.0	1.0	1.6	1.4	63.07	1.072	2.77	11.84	3.70	11.82
1820	Nov. 14	...do	1	9.0	.7	1.2	1.0	59.40	1.069	2.49	10.95	3.17	10.81
1849	Nov. 16	...do	1	8.2	.8	.8	.6	51.43	1.071	.51	12.23	4.40	....
1879	Nov. 18	...do	1	9.0	.8	1.1	1.0	60.72	1.064	3.97	8.22	4.35	8.12

MASTODON.

D. W. Aiken.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
44	July 7	1	2	5.0	1.2	3.5	2.7	65.67	1.016	1.84	.32	2.17	....
209	July 16	2	1	6.5	.8	1.4	1.1	68.55	1.028	3.78	1.15	2.14	....
382	July 25	3	1	7.5	1.1	2.6	2.0	66.11	1.033	4.73	2.36	1.91	2.01
407	July 27	3	1	7.5	.8	1.6	1.2	66.61	1.038	2.07	5.28	2.33	5.84
477	July 30	4	1	8.6	.8	1.9	1.5	67.47	1.035	5.48	2.32	3.69	....

MASTODON—Continued.

D. W. AIKEN—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
521	Aug. 2	4	1	10.0	1.0	2.7	2.2	70.51	1.034	3.20*	3.63	2.40	......
569	Aug. 6	5	1	9.5	1.1	2.7	2.2	69.55	1.040	4.62	4.75	1.25	3.59
680	Aug. 11	6	1	10.5	.9	1.6	1.3	68.43	1.053	4.21	8.07	1.96	7.75
699	Aug. 16	7	1	11.6	.9	2.4	2.0	69.07	1.049	6.01	4.41	1.96	3.74
700	Aug. 16	8	1	10.5	.9	1.8	1.4	69.76	1.053	3.47	7.75	2.93	7.44
787	Aug. 22	9	1	9.7	.9	2.2	1.7	66.23	1.057	4.25	8.98	1.48	8.06
865	Aug. 26	10	1	12.5	.9	1.8	1.5	66.26	1.046	6.09	4.66	1.00	4.14
916	Aug. 30	11	1	9.9	.7	1.7	1.3	58.62	1.075	1.45	14.80	2.96	13.68
975	Sept. 2	12	1	9.9	.8	1.7	1.4	64.81	1.072	1.20	15.48	2.85	13.47
1032	Sept. 5	13	1	11.2	1.1	2.5	2.2	65.58	1.074	4.24	11.89	2.58	11.50
1090	Sept. 9	14	1	11.4	.9	1.9	1.7	66.00	1.073	1.51	14.27	2.51	12.92
1102	Sept. 9	14	......	......	......	......	......	......	1.073	1.51	14.60	3.46	13.78
1183	Sept. 15	15	1	11.1	1.0	2.3	2.0	60.07	1.064	2.64	11.31	5.03	......
1257	Sept. 27	18	1	12.0	1.1	2.0	1.6	50.63	1.080	.70	16.07	3.50	......
1329	Oct. 3	After 18	1	9.2	.9	1.8	1.6	51.72	1.082	1.27	15.91	2.66	......
1494	Oct. 14	...do	1	12.0	1.1	3.0	2.3	62.71	1.053	1.58	9.45	2.31	8.65
1546	Oct. 19	...do	1	11.5	1.0	2.3	1.8	61.27	1.049	3.45	5.54	2.73	5.48
1598	Oct. 26	...do	1	10.6	1.3	2.6	2.1	61.15	1.067	1.25	12.17	2.84	11.59
1631	Oct. 28	...do	1	9.6	.6	1.3	1.0	64.36	1.061	2.32	9.91	4.35	9.87
1665	Nov. 1	...do	1	11.0	1.3	2.4	2.1	64.04	1.066	1.81	11.96	2.88	11.72
1697	Nov. 3	...do	1	8.5	.9	1.5	1.2	65.54	1.055	3.43	7.43	3.17	7.23
1728	Nov. 5	...do	1	8.5	1.1	1.9	1.6	65.82	1.047	3.61	5.01	3.55	5.12
1762	Nov. 8	...do	1	9.7	1.0	1.9	1.4	69.97	1.056	3.24	7.87	4.13	7.47
1798	Nov. 11	...do	1	7.3	.7	.7	.6	57.60	1.058	.64	7.92	5.05	8.45
1821	Nov. 14	...do	1	9.5	.9	1.3	1.0	62.26	1.069	1.07	12.15	3.15	12.21
1850	Nov. 16	...do	1	11.0	1.2	2.0	1.8	67.61	1.044	3.65	4.66	3.13	4.46
1880	Nov. 18	...do	1	12.0	1.1	1.9	1.5	63.77	1.069	.81	11.77	4.81	12.06

HONDURAS.

E. LINK.

42	July 7	....	2	2.8	1.1	2.7	2.0	57.09	1.015	1.91	.16	2.85	......
428	July 28	....	1	6.3	1.1	2.2	1.7	67.77	1.032	5.12	1.56	2.04	1.17
478	July 30	....	1	5.5	1.1	2.3	1.9	63.53	1.031	5.03	1.63	1.90	.58
522	Aug. 2	1	2	8.0	.9	4.4	3.5	69.97	1.035	5.08	1.51	3.60	......
632	Aug. 11	2	1	7.5	1.3	3.4	2.7	70.99	1.045	5.04	5.04	1.78	4.18
633	Aug. 11	3	1	9.7	1.0	2.7	2.1	68.30	1.044	6.25	3.88	1.74	3.11
634	Aug. 11	4	1	8.5	1.3	3.7	2.9	63.78	1.043	5.21	4.19	2.58	3.72
701	Aug. 16	5	1	10.5	.8	2.0	1.7	69.21	1.055	6.12	5.89	1.93	5.24
702	Aug. 16	6	1	10.6	.9	2.3	1.8	71.41	1.055	6.04	5.96	1.75	5.63
768	Aug. 22	7	1	10.0	1.0	2.8	2.2	66.70	1.062	4.47	9.64	1.99	8.89
791	Aug. 22	7	......	......	......	......	......	......	1.062	4.29	10.15	1.60	8.89
866	Aug. 26	8	1	11.5	1.0	2.6	2.1	66.70	1.061	5.86	8.30	1.29	7.96
917	Aug. 30	9	1	10.4	1.1	2.5	2.0	62.82	1.072	4.31	11.89	1.99	11.14
976	Sept. 2	10	1	10.5	1.0	2.4	2.1	65.18	1.075	3.22	13.98	2.89	13.26
1001	Sept. 2	10	......	......	......	......	......	......	1.074	3.43	13.66	1.90	12.97
1033	Sept. 5	11	1	10.8	1.1	2.9	2.5	67.92	1.073	3.26	13.45	1.98	11.65
1091	Sept. 9	12	1	10.0	1.0	2.2	2.0	71.20	1.065	4.93	9.54	2.41	9.63
1101	Sept. 9	12	......	......	......	......	......	......	1.065	5.28	9.79	2.11	8.33
1184	Sept. 15	13	1	10.7	1.0	1.9	1.6	59.56	1.076	2.55	14.23	5.43	13.74
1258	Sept. 27	18	1	11.3	1.0	4.4	1.9	62.85	1.072	2.56	13.58	2.53	12.77
1330	Oct. 3	After 18	1	10.8	1.0	2.3	1.8	57.28	1.079	2.31	14.55	3.11	......
1495	Oct. 14	...do	1	10.4	.9	1.7	1.5	67.31	1.048	4.77	4.64	2.61	4.63
1547	Oct. 19	...do	1	9.6	1.2	2.1	1.8	63.11	1.056	4.52	6.77	2.10	6.60
1599	Oct. 26	...do	1	10.8	.9	1.7	1.3	64.37	1.055	4.17	5.48	3.81	6.02
1632	Oct. 28	...do	1	9.5	.9	1.6	1.2	64.87	1.054	4.67	6.06	2.60	5.57
1666	Nov. 1	...do	1	10.8	1.1	2.4	2.0	64.15	1.048	4.98	4.80	2.63	4.65
1698	Nov. 3	...do	1	8.5	.7	1.3	1.2	60.67	1.052	1.96	8.03	3.36	[illegible]
1729	Nov. 5	...do	1	11.0	.9	1.6	1.5	65.77	1.052	4.38	5.75	3.84	[illegible]
1763	Nov. 8	...do	1	10.5	1.0	2.2	1.8	67.54	1.056	2.98	8.00	3.65	[illegible]
1793	Nov. 11	...do	1	9.3	.8	1.1	.8	58.93	1.048	3.36	5.10	3.64	[illegible]
1822	Nov. 14	...do ...	1	10.9	1.1	2.1	1.9	65.69	1.049	3.19	6.04	3.01	[illegible]
1851	Nov. 16	...do	1	9.5	.8	1.0	.9	64.63	1.043	2.38	4.69	3.08	4.46
1881	Nov. 18	...do	1	10.5	1.0	1.4	1.3	65.22	1.051	3.16	6.14	4.11	5.67

SUGAR CANE.

C. E. MILLER.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
190	July 16	1	1	5.0	.7	1.1	.8	71.12	1.038	4.31	3.41	3.64	....
43	July 7	2	2	5.0	.8	2.5	2.0	73.52	1.023	3.48	.27	4.99	....
62	July 9	3	1	6.0	.9	1.1	.8	69.16	1.023	3.56	.67	3.15	....
110	July 12	4	1	7.0	.9	1.2	.9	72.92	1.025	4.02	.49	4.12	....
170	July 15	4	1	6.3	.8	1.3	1.0	68.66	1.024	2.78	1.64	3.88	....
111	July 12	5	1	7.3	.8	1.4	1.1	69.82	1.027	3.28	2.03	3.01	....
171	July 15	5	1	6.0	.7	1.0	.7	61.85	1.029	3.62	1.21	4.40	....
210	July 16	6	1	6.0	.7	1.0	.7	65.90	1.029	4.36	.73	2.34	....
238	July 18	7	1	6.0	.8	.9	.7	62.95	1.045	4.43	4.95	1.19	....
267	July 19	8	1	5.5	.7	.9	.6	71.38	1.045	4.90	3.74	3.32	....
279	July 20	9	1	5.6	.6	1.0	.7	62.87	1.048	4.47	5.70	3.09	....
326	July 22	9	1	6.5	.6	1.1	.8	68.83	1.048	4.57	5.84	2.23	....
406	July 27	10	1	6.3	.7	1.3	.8	68.42	1.046	3.92	6.63	1.97	6.28
523	Aug. 2	11	1	7.4	.8	1.5	1.0	68.48	1.049	3.44	6.31	5.24	....
524	Aug. 2	12	2	6.2	.6	2.2	1.3	67.32	1.039	3.24	4.00	2.91	....
703	Aug. 16	13	1	8.0	.7	1.4	1.0	66.85	1.064	3.58	9.57	2.92	....
789	Aug. 22	14	1	8.0	.8	1.7	1.2	66.60	1.073	2.62	13.56	2.23	12.92
867	Aug. 26	15	1	10.1	.9	2.6	2.0	67.00	1.070	3.56	12.27	2.48	12.25
918	Aug. 30	16	1	7.4	.6	.9	.6	54.94	1.081	1.73	15.49	3.45	14.89
977	Sept. 2	17	2	7.0	.8	2.1	1.5	62.66	1.072	4.30	12.82	3.06	11.09
1034	Sept. 5	17	1	8.4	.7	1.3	1.0	61.47	1.082	1.61	17.99	1.24	....
1092	Sept. 9	18	2	6.0	.7	1.8	1.0	59.53	1.073	5.18	9.80	4.40	....
1186	Sept. 15	18	1	7.7	.7	1.0	.8	63.11	1.070	3.73	11.14	3.82	10.59
1250	Sept. 27	18	1	8.0	.7	.9	.7	61.82	1.070	3.32	11.54	3.17	....
1331	Oct. 3	After 18	1	9.0	.7	1.0	.7	57.98	1.068	1.60	16.22	4.17	....
1498	Oct. 14	...do	1	8.2	.8	.9	.8	56.11	1.067	2.46	10.19	3.28	9.77
1548	Oct. 19	.. do	1	7.0	.7	.8	.7	50.16	1.075	1.22	13.32	3.08	....
1600	Oct. 26	...do ...	1	8.0	.7	1.1	1.0	59.73	1.068	2.92	9.85	3.84	10.61
1635	Oct. 29	...do	2	6.5	.8	1.2	1.0	61.53	1.052	3.18	6.29	3.53	....
1667	Nov. 1	...do	1	8.0	.9	1.0	.9	57.28	1.055	2.78	7.60	3.60	7.49
1699	Nov. 3	...do	1	10.0	.9	1.6	1.0	54.13	1.057	3.37	8.49	3.01	8.08
1730	Nov. 5	...do	1	8.5	.7	1.2	1.0	61.02	1.044	1.65	6.36	3.67	5.62
1764	Nov. 8	...do	1	8.7	.6	1.1	1.0	61.84	1.062	2.36	10.10	3.73	9.76
1794	Nov. 11	...do	1	9.5	.9	1.0	.9	64.17	1.046	1.58	5.33	4.32	....
1823	Nov. 14	...do	1	8.4	.7	.8	.7	56.72	1.059	2.93	8.79	3.15	8.43
1852	Nov. 16	.. do	1	9.2	.8	1.3	.9	61.16	1.056	3.76	7.80	3.07	7.45
1883	Nov. 18	...do	1	7.5	.8	.8	.7	61.87	1.051	3.08	6.86	3.66	6.44

HYBRID No. 4.

WILL N. WALLIS.

24	July 6	1	2	5.0	.9	2.3	1.8	68.15	1.016	2.71	.23	1.77	....
70	July 9	1	1	6.3	1.0	1.5	1.2	68.11	1.020	3.18	.42	2.77	....
112	July 12	2	1	6.0	.9	1.1	1.0	71.46	1.019	3.06	.37	2.85	....
113	July 12	3	1	6.5	.9	1.5	1.0	71.25	1.019	3.37	.05	2.31	....
114	July 14	4	1	7.3	.7	1.3	1.0	73.89	1.020	3.49	.11	5.05	....
211	July 16	5	1	8.5	.8	1.5	1.1	71.43	1.028	4.74	.23	3.24	....
212	July 16	6	1	8.5	.8	1.8	1.4	70.08	1.029	4.67	.13	3.75	....
239	July 18	7	1	9.7	.8	1.7	1.3	66.38	1.034	5.07	1.56	1.59	....
290	July 20	8	1	9.7	.8	1.7	1.4	69.52	1.036	5.61	.22	4.44	....
310	July 22	8	1	9.0	.8	1.0	1.2	63.21	1.041	5.34	3.81	1.89	....
325	July 22	9	1	9.6	.8	1.6	1.3	70.02	1.040	5.11	3.81	2.85	....
409	July 27	10	1	9.8	.7	1.7	1.3	70.37	1.045	4.96	5.75	1.73	5.52
492	Aug. 1	11	2	9.5	.9	3.8	3.0	73.57	1.057	3.96	8.83	2.89	8.14
496	Aug. 1	11	......	......	......	......	......	......	1.041	3.66	8.51	3.33	....
525	Aug. 2	11	2	9.7	.8	3.5	2.6	66.24	1.060	3.47	8.91	3.37	....
636	Aug. 11	12	1	9.2	.8	1.5	1.0	69.05	1.065	3.34	11.66	2.37	11.25
682	Aug. 11	11	1	9.5	.7	1.1	.8	6[illegible].32	1.059	6.28	7.38	2.15	6.99
704	Aug. 16	13	1	9.0	.8	1.7	1.2	66.25	1.070	3.27	12.20	2.43	11.43
790	Aug. 22	14	1	8.7	.8	1.5	.9	65.00	1.066	3.00	12.78	3.18	12.04
[illegible]	Aug. 26	15	1	9.0	.8	1.3	1.0	65.06	1.073	3.43	13.30	.66	12.70
919	Aug. 30	16	1	9.7	.8	1.3	1.0	57.02	1.077	2.06	14.22	2.71	13.88
978	Sept. 3	17	1	9.5	.9	1.4	1.1	61.20	1.080	2.00	15.56	3.50	14.40
1023	Sept. 5	17	1	9.1	.8	1.3	1.1	59.95	1.083	2.42	16.09	2.72	....
1093	Sept. 9	18	1	9.7	.9	1.5	1.2	62.78	1.077	4.16	13.05	2.28	11.62

HYBRID No. 4—Continued.

Will N. Wallis—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
1186	Sept. 15	18	1	8.7	.6	1.0	.6	62.24	1.070	3.82	11.65	3.68	....
1332	Oct. 3	After 18	1	10.0	.8	1.4	1.1	63.72	1.071	4.14	11.70	2.74	11.04
1509	Oct. 15	...do	1	9.9	.9	1.2	.8	50.73	1.052	3.96	6.50	2.97	5.15
1549	Oct. 19	...do	1	9.8	.9	1.1	.9	55.68	1.055	4.12	6.77	2.47	6.06
1601	Oct. 26	...do	1	8.6	.9	1.3	1.0	60.18	1.059	4.40	7.32	3.29	6.94
1636	Oct. 29	...do	1	9.0	.8	1.3	.8	60.58	1.055	4.20	6.32	3.46	....
1668	Nov. 1	...do	1	10.8	.8	1.4	1.0	60.22	1.051	3.75	6.55	3.21	6.09
1700	Nov. 3	...do	1	8.0	.8	1.2	1.0	64.57	1.046	1.37	7.56	3.21	7.55
1731	Nov. 5	...do	1	9.7	.8	1.3	1.0	58.91	1.061	3.88	8.97	3.58	8.49
1765	Nov. 8	...do	1	10.0	.7	1.4	.9	60.18	1.046	4.43	5.11	2.31	3.87
1795	Nov. 11	...do	1	7.0	.7	1.6	1.2	61.42	1.049	4.33	4.66	3.40	3.86
1824	Nov. 14	...do	1	9.6	.9	1.2	.9	60.14	1.053	3.52	6.88	2.94	6.50
1853	Nov. 16	...do	1	6.7	.8	.9	.8	65.86	1.052	1.29	8.19	3.49	....
1883	Nov. 18	...do	1	9.5	.9	.9	.7	57.14	1.040	3.66	3.06	4.33	2.29

WHITE IMPHEE.

John N. Barger.

41	July 7	....	3	3.0	.9	2.8	2.1	63.49	1.021	2.38	.39	2.37	....
115	July 13	1	1	5.0	.9	1.3	.9	60.81	1.025	3.45	1.06	2.31	....
213	July 16	2	1	5.8	.8	1.3	1.0	67.33	1.030	4.12	.90	3.18	....
281	July 20	3	1	6.3	.8	1.0	.8	66.57	1.032	4.23	1.04	4.23	....
311	July 22	3	1	7.4	.8	1.4	1.0	68.51	1.037	4.18	3.80	2.19	....
323	July 22	4	1	7.5	.9	1.7	1.2	71.07	1.037	4.22	3.55	2.01	....
363	July 25	5	1	7.4	.8	1.2	.8	65.70	1.044	3.96	5.55	2.34	5.27
410	July 27	5	1	7.9	.7	1.2	.9	71.43	1.042	3.97	5.74	1.51	4.54
454	July 29	6	1	7.8	.8	1.8	1.0	68.36	1.054	4.68	7.41	2.42	7.45
526	Aug. 2	7	2	8.0	.7	2.8	2.0	66.29	1.065	3.01	8.85	4.85	....
570	Aug. 6	8	1	8.0	.8	1.5	1.2	65.33	1.066	3.40	11.47	2.95	11.11
635	Aug. 11	8	1	7.1	.7	1.0	.6	57.00	1.077	3.25	14.34	2.46	13.19
705	Aug. 16	9	1	7.8	.8	2.1	1.5	66.91	1.068	2.57	12.49	1.84	11.28
792	Aug. 22	10	1	7.5	.8	1.7	1.1	70.02	1.061	2.74	8.58	1.63	7.89
869	Aug. 26	11	1	8.2	.8	1.4	1.1	64.60	1.079	1.77	15.52	1.67	15.05
920	Aug. 30	12	1	8.7	.7	1.3	1.1	58.33	1.082	1.15	16.85	3.25	16.34
979	Sept. 2	13	1	7.7	.9	1.4	1.1	65.05	1.074	1.47	14.97	3.57	....
1036	Sept. 5	14	1	9.2	.8	1.5	1.2	60.95	1.088	1.20	18.24	2.25	17.14
1094	Sept. 9	15	1	8.7	.9	1.6	1.3	61.06	1.089	1.48	19.25	2.41	....
1187	Sept. 15	16	1	7.8	.8	1.4	1.1	57.02	1.083	.86	16.73	4.38	....
1333	Oct. 3	After 18	1	8.3	.8	1.7	1.0	56.77	1.085	1.20	16.85	4.15	....
1510	Oct. 15	...do	1	8.0	.9	1.1	.8	64.08	1.045	1.07	7.27	3.14	6.70
1565	Oct. 22	...do	1	8.3	.7	1.2	.9	63.13	1.055	2.07	8.84	3.02	8.67
1602	Oct. 26	...do	1	8.0	.9	1.0	.9	59.35	1.052	1.78	6.88	4.06	7.69
1637	Oct. 29	...do	1	7.6	.9	1.2	.8	63.11	1.053	1.47	8.25	3.62	....
1669	Nov. 1	...do	1	7.6	.9	1.3	.9	67.90	1.047	2.07	7.03	2.86	6.90
1701	Nov. 3	...do	1	9.5	.9	2.0	1.5	62.00	1.066	1.70	11.47	3.03	....
1732	Nov. 5	...do	1	5.7	.6	1.0	.8	65.59	1.046	1.84	6.29	3.77	6.46
1766	Nov. 8	...do	1	4.3	.5	1.1	.8	62.70	1.041	1.99	5.04	3.05	4.99
1796	Nov. 11	...do	1	8.5	.8	1.4	.9	55.18	1.062	1.42	8.15	3.50	8.17
1825	Nov. 14	...do	1	8.0	.8	1.0	.8	62.88	1.053	1.44	9.31	2.64	9.19
1854	Nov. 16	...do	1	9.5	.9	.9	.8	59.79	1.043	2.55	3.87	4.03	3.37

GOOSE NECK.

G. N. Gibson.

61	July 9	....	1	5.0	1.0	1.8	1.0	69.35	1.014	1.91	.93	3.12	....
116	July 13	1	1	5.0	.9	1.3	1.0	62.62	1.021	2.86	.24	2.38	....
117	July 13	2	1	4.5	.9	1.6	1.1	65.14	1.017	2.98	.31	1.87	....
118	July 13	3	1	4.8	1.1	1.6	1.1	65.29	1.020	2.88	....	3.23	....
322	July 22	4	1	8.3	.9	1.9	1.4	69.23	1.032	4.78	1.65	1.70	....
429	July 28	5	1	8.2	.7	1.5	1.1	64.60	1.039	5.16	4.11	1.46	2.72

GOOSE NECK—Continued.

G. N. Gibson—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
435	July 29	5	......	......	......	......	......	......	1.039	5.47	3.29	1.49	2.80
456	July 29	6	1	9.0	.8	2.0	1.8	58.45	1.046	4.89	4.99	2.54	4.28
511	Aug. 2	7	1	9.0	.9	2.0	1.4	62.36	1.053	3.35	7.48	4.83	....
571	Aug. 6	8	1	9.5	.7	1.7	1.8	65.12	1.055	4.68	7.83	2.56	7,04
638	Aug. 11	8	1	8.7	.9	2.0	1.5	66.96	1.058	5.78	8.81	.98	6.22
639	Aug. 11	9	1	9.0	.9	2.1	1.5	64.26	1.065	4.46	10.25	1.76	9.14
719	Aug. 17	10	1	9.6	.9	2.3	1.5	58.71	1.065	2.05	11.59	4.34	....
793	Aug. 22	11	1	9.6	.8	1.9	1.8	65.82	1.066	3.28	11.16	2.35	10.68
870	Aug. 26	12	1	9.8	.9	2.2	1.6	46.09	1.068	2.21	13.14	2.58	12.32
921	Aug. 30	13	1	9.5	.9	2.0	1.4	61.14	1.070	1.89	13.85	2.39	....
980	Sept. 2	14	1	9.2	.9	1.9	1.3	60.24	1.076	2.07	15.18	3.10	13.47
1037	Sept. 5	15	1	9.0	.9	2.7	1.8	57.84	1.078	1.88	15.59	2.09	....
1095	Sept. 9	16	1	8.4	.8	1.6	1.3	60.10	1.077	1.88	16.00	2.00	....
1188	Sept. 15	17	1	8.8	1.0	2.1	1.6	57.58	1.079	1.21	14.37	5.27	....
1344	Oct. 4	After 18	1	10.2	.9	2.3	1.7	52.94	1.082	1.50	14.86	3.27	....
1511	Oct. 15	...do	1	9.9	1.1	2.9	1.8	60.39	1.071	1.92	12.15	1.96	10.79
1566	Oct. 22	...do	1	9.0	.8	2.1	1.4	61.37	1.075	1.97	12.66	3.93	....
1603	Oct. 26	...do	1	10.0	.9	2.4	1.7	60.36	1.075	1.62	12.90	4.08	12.84
1638	Oct. 29	...do	1	9.0	.9	2.1	1.7	63.46	1.069	1.75	11.62	3.60	11.74
1670	Nov. 1	...do	1	9.0	1.0	2.1	1.6	63.77	1.065	2.17	11.28	3.21	10.76
1702	Nov. 3	...do	1	8.5	.8	1.6	1.0	56.91	1.069	.81	12.66	4.06	....
1733	Nov. 5	...do	1	9.5	.8	1.7	1.2	62.20	1.052	2.82	6.90	4.15	6.77
1767	Nov. 8	...do	1	8.0	.6	1.1	.7	61.12	1.039	3.16	2.83	3.34	....
1797	Nov. 11	...do	1	9.0	.7	1.2	1.0	57.17	1.065	2.15	10.48	3.42	10.25
1828	Nov. 14	...do	1	9.5	.7	.9	.7	59.27	1.044	3.11	6.36	1.11	3.74
1855	Nov. 16	...do	1	7.5	.7	1.2	.9	54.95	1.064	1.48	10.26	4.37	....

WHITE AFRICAN.

J. N. Barger.

25	July 6	1	2	5.3	.8	2.2	1.7	65.13	1.017	2.39	.41	2.26	....
191	July 16	2	1	6.0	.7	1.1	.8	71.62	1.024	3.66	.98	5.02	....
71	July 9	3	1	6.0	1.0	1.5	1.2	69.83	1.019	2.51	.35	5.28	....
119	July 13	4	1	6.7	.8	1.3	1.0	67.50	1.024	2.99	.62	2.00	....
172	July 15	5	1	7.0	.8	1.3	1.0	68.09	1.028	3.35	1.54	3.52	....
214	July 15	6	1	7.5	.7	1.3	1.0	67.66	1.023	3.70	.81	2.43	....
282	July 20	7	1	7.8	.7	1.3	1.1	67.63	1.037	3.88	....	3.83	....
312	July 22	7	1	8.0	.6	1.1	.9	67.69	1.036	4.10	.26	5.58	....
321	July 22	8	1	8.8	.6	1.5	1.2	67.85	1.039	3.85	4.29	1.96	....
514	Aug. 2	9	1	8.5	.8	1.5	1.2	65.17	1.058	2.42	9.27	2.20	....
544	Aug. 3	10	1	7.8	.8	1.5	1.2	65.08	1.064	2.25	8.11	4.15	....
640	Aug. 11	11	1	7.5	.9	1.6	1.2	65.43	1.066	3.10	11.32	2.88	10.94
720	Aug. 17	12	1	7.9	.8	1.4	1.0	61.75	1.078	2.03	13.36	3.24	....
794	Aug. 22	13	1	8.3	.8	1.7	1.1	60.34	1.073	2.00	14.25	2.24	13.30
871	Aug. 26	14	1	8.9	.8	1.8	1.2	52.33	1.072	1.80	14.44	2.04	14.28
925	Aug. 31	15	1	8.0	.7	1.5	1.0	54.36	1.079	1.82	15.89	2.53	....
981	Sept. 2	16	1	8.5	.7	1.4	1.0	60.22	1.079	1.50	15.45	4.27	....
1038	Sept. 5	17	1	9.5	.8	1.9	1.3	58.42	1.080	1.96	15.39	3.11	....
1096	Sept. 9	17	1	8.4	.8	1.6	1.1	58.77	1.077	1.70	16.14	2.40	....
1189	Sept. 15	18	1	9.0	.7	1.6	1.1	61.09	1.077	1.83	14.62	4.47	....
1345	Oct. 4	After 18	1	8.2	.8	1.3	1.0	39.57	1.078	1.43	13.50	3.34	....
1512	Oct. 15	...do	1	6.5	.9	......	1.1	59.51	1.066	1.28	11.69	4.00	....
1567	Oct. 22	...do	1	9.1	.7	2.0	1.2	59.47	1.078	.86	13.81	4.67	15.23
1604	Oct. 26	...do	1	8.0	.8	1.7	1.0	54.85	1.071	1.10	12.41	4.09	12.48
1639	Oct. 29	...do	1	7.0	.8	1.5	1.0	59.36	1.075	1.05	13.34	4.02	13.56
1671	Nov. 1	...do	1	8.0	.8	2.0	1.2	51.44	1.067	1.23	11.77	4.05	11.19
1703	Nov. 3	...do	1	8.0	.8	1.5	1.1	61.04	1.075	1.59	13.74	3.69	13.41
1734	Nov. 5	...do	1	9.0	.7	1.6	1.0	58.31	1.069	1.22	11.17	5.04	11.74
1768	Nov. 8	...do	1	7.0	.7	1.2	1.1	57.08	1.067	.96	11.46	3.79	....
1798	Nov. 11	...do	1	7.5	.8	1.0	.9	56.61	1.064	1.38	9.68	4.54	9.38
1827	Nov. 14	...do	1	8.5	.7	1.2	.9	57.79	1.066	1.25	10.64	4.05	....
1856	Nov. 16	...do	1	5.8	.7	.8	.7	56.85	1.071	1.12	13.60	2.83	12.80

WEST INDIA SUGAR CANE.

D. C. SNOW.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		Feet.	Inches.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.
430	July 28	1	1	6.3	1.1	2.2	1.7	67.72	1.036	5.93	2.03	1.50	1.29
433	July 29	1	......	......	......	......	......	....	1.036	6.03	1.72	1.95	1.27
449	July 29	2	......	......	......	......	......	....	1.040	5.36	3.13	2.71	2.76
457	July 29	2	1	6.0	1.0	2.2	1.8	63.25	1.040	5.44	3.15	2.79	2.85
479	July 30	3	1	7.0	.9	1.8	1.4	66.35	1.044	5.44	3.73	3.28	2.23
540	Aug. 8	3	1	6.4	.7	1.2	.9	61.83	1.046	5.05	4.17	3.25	....
545	Aug. 8	4	1	7.8	.9	2.1	1.6	60.75	1.050	5.06	5.27	....	....
572	Aug. 8	5	1	9.0	.9	1.9	1.5	65.02	1.054	5.09	6.91	2.58	6.60
721	Aug. 17	6	1	7.5	1.0	2.9	2.0	61.05	1.070	4.00	11.18	1.27	10.69
796	Aug. 22	7	1	8.6	1.0	2.6	2.0	68.27	1.075	3.25	14.07	2.04	12.01
872	Aug. 26	8	1	8.4	.9	2.0	1.8	53.10	1.083	3.34	14.86	2.42	14.41
926	Aug. 31	9	1	9.3	1.0	2.3	1.8	67.18	1.083	2.53	15.78	2.09	15.26
.....	Sept. 2	10	1	8.7	.9	2.1	1.7	60.86	1.088	1.89	17.44	4.38	17.74
.....	Sept. 5	11	1	8.7	.9	2.4	1.9	62.61	1.090	2.80	17.64	2.94	15.18
1097	Sept. 9	12	1	8.5	.9	2.0	1.6	62.55	1.087	1.70	18.87	2.07	....
1190	Sept. 15	13	1	7.7	.9	1.7	1.4	57.55	1.081	2.54	14.47	4.26	....
1346	Oct. 4	After 18	1	8.5	1.0	2.2	1.7	56.02	1.085	1.36	15.78	3.22	....

SUGAR CANE.

JOHN N. BARGER.

26	July 6	1	2	5.2	.6	2.1	1.6	69.72	1.019	3.10	.28	1.78	....
192	July 16	2	1	5.5	.6	.8	.6	67.46	1.024	3.72	.30	1.97	....
72	July 9	3	1	5.8	.9	1.2	.8	70.13	1.021	3.21	.24	2.96	....
120	July 13	4	1	5.5	.9	1.4	1.0	68.01	1.020	3.01	....	2.23	....
121	July 13	5	1	6.3	.9	1.3	1.0	68.79	1.026	4.23	....	2.49	....
173	July 15	6	1	7.0	.8	1.1	.8	67.90	1.021	4.19	.37	3.71	....
215	July 16	7	1	7.0	.7	1.0	.7	72.29	1.031	4.76	.71	2.77	....
240	July 18	8	1	6.0	.9	1.5	1.1	64.53	1.037	4.62	4.76	....	....
320	July 22	9	1	7.3	.7	1.2	.9	69.50	1.042	4.84	3.94	2.35	....
541	Aug. 3	10	1	5.8	.8	1.6	1.0	65.73	1.051	4.10	6.62	3.07	....
641	Aug. 11	11	1	8.7	.7	1.5	1.0	66.36	1.040	4.92	3.19	3.04	3.69
722	Aug. 17	12	1	7.5	.7	1.2	.9	71.32	1.059	4.30	9.09	1.71	....
797	Aug. 22	13	1	7.5	.8	1.7	1.3	68.62	1.046	4.06	5.07	1.98	4.30
873	Aug. 26	14	1	7.6	.8	1.4	1.0	62.55	1.067	3.85	11.57	1.57	10.89
927	Aug. 31	15	1	7.6	.8	1.4	1.1	65.35	1.070	3.53	11.55	3.50	10.48
983	Sept. 2	16	1	7.6	.9	1.4	1.1	67.18	1.064	3.78	11.27	2.43	9.32
1040	Sept. 5	17	1	9.2	.9	2.2	1.7	62.09	1.043	2.85	17.07?	3.38	16.01
1098	Sept. 9	17	1	7.5	.8	1.3	1.0	58.39	1.075	2.07	15.80	1.13	13.79
1191	Sept. 15	18	1	8.0	1.0	1.3	1.0	68.81	1.074	2.57	13.88	4.30	12.99
1347	Oct. 4	After 18	1	7.0	.8	1.1	.8	61.05	1.075	2.26	12.97	2.21	12.68

NEW VARIETY OF LIBERIAN AND OOMSEEANA.

J. N. BARGER.

193	July 16	1	1	4.5	.8	.9	.7	67.54	1.024	3.78	.78	2.81	....
38	July 7	2	2	4.0	1.0	2.2	1.6	66.47	1.020	3.44	....	2.44	....
60	July 9	3	2	4.5	.8	2.3	1.6	65.00	1.021	3.06	.46	3.14	....
122	July 13	4	1	5.5	.7	1.1	.9	64.25	1.026	4.02	.23	2.57	....
123	July 13	5	1	5.6	1.0	1.3	.9	66.58	1.029	4.71	.48	2.48	....
216	July 16	6	1	6.0	.8	1.2	.9	67.86	1.030	4.77	.18	1.99	....
241	July 18	7	1	6.6	.8	1.3	1.0	76.81	1.035	4.89	1.67	3.68	....
283	July 20	8	1	6.5	.7	1.3	1.0	71.03	1.043	5.07	....	5.07	....
313	July 22	8	1	6.5	.7	1.3	.9	61.37	1.043	5.22	4.28	2.53	....
364	July 25	9	1	6.0	.8	1.3	.9	65.13	1.050	4.61	6.52	2.67	2.93
386	July 26	9	1	5.8	.8	1.5	1.1	66.86	1.046	4.89	4.94	2.21	....
458	July 29	10	1	6.0	.9	1.2	.9	65.56	1.057	4.71	7.55	3.11	7.66
542	Aug. 3	10	1	6.2	.7	1.4	.9	68.30	1.050	3.72	8.25	4.22	....
644	Aug. 12	11	1	7.0	.7	1.3	.9	59.39	1.067	3.10	12.30	2.22	11.76
723	Aug. 17	12	1	6.1	.7	1.1	.7	68.78	1.075	3.02	13.08	3.20	12.71
798	Aug. 22	13	1	6.5	.7	1.1	1.0	52.47	1.073	3.18	12.88	2.67	11.55
874	Aug. 26	14	1	6.5	.8	1.3	.8	72.04	1.075	3.15	14.03	1.28	12.62
928	Aug. 31	15	1	6.0	.8	1.4	.9	60.44	1.078	3.21	13.55	2.86	13.11

NEW VARIETY OF LIBERIAN AND OOMSEEANA.—Continued.

J. N. BARGER—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
984	Sept. 2	16	1	6.7	.8	1.1	.8	56.53	1.082	1.98	16.06	4.22	15.72
1041	Sept. 5	17	1	5.7	.8	1.5	.9	56.50	1.042	2.27	16.54	4.70	16.03
1099	Sept. 9	17	1	6.4	.8	1.4	.9	61.72	1.075	2.72	15.13	2.83	12.56
1192	Sept. 15	18	1	7.6	.8	1.5	1.0	58.64	1.076	2.14	14.70	2.28	14.04
1348	Oct. 4	After 18	1	6.3	.8	1.6	.9	55.23	1.071	2.17	12.57	2.52	12.29

MINNESOTA EARLY AMBER.

VILMORIN.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
27	July 6	1	2	5.3	.8	2.2	1.8	68.90	1.018	3.15	.33	1.85	....
194	July 16	2	1	6.0	.7	1.2	.9	66.51	1.041	2.75	5.84	2.09	....
73	July 9	3	1	5.8	.9	1.3	1.3	68.83	1.023	3.32	.28	2.54	....
83	July 11	3	2	7.5	.8	2.6	2.2	68.26	1.023	3.17	1.11	2.21	....
124	July 13	4	1	7.0	.9	1.5	1.2	71.71	1.024	3.17	.81	2.21	....
125	July 13	5	1	7.3	.8	1.3	1.1	70.32	1.021	3.23	.82	2.06	....
126	July 13	6	1	8.3	1.0	1.6	1.3	66.72	1.026	3.45	1.90	1.09	....
217	July 16	7	1	8.5	.9	1.7	1.4	72.77	1.034	3.38	.39	4.56	....
242	July 18	8	1	8.5	.8	1.3	1.1	72.00	1.040	.96	6.86	1.31	....
268	July 19	9	1	8.0	.7	1.2	.9	72.47	1.047	3.43	6.39	2.21	....
284	July 20	9	1	8.4	.7	1.4	1.1	70.80	1.040	3.10	....	3.10	....
308	July 21	9	1	8.9	.7	1.5	1.2	71.29	1.039	2.50	5.57	....	....
314	July 22	9	1	8.5	.7	1.3	1.0	69.70	1.052	2.94	8.78	1.96	....
365	July 25	10	1	8.0	.7	1.4	1.1	64.59	1.053	3.15	8.52	1.91	8.73
450	July 29	10	1	9.0	.7	1.4	1.1	63.38	1.067	2.18	12.59	2.07	12.90
480	July 30	11	1	7.5	.8	1.5	1.2	67.89	1.064	2.70	10.71	5.43	8.98
543	Aug. 3	11	1	7.5	.9	1.4	1.2	63.71	1.067	1.85	11.82	3.76	....
645	Aug. 12	12	1	7.2	.8	1.6	1.4	61.60	1.060	1.47	15.40	1.76	14.19
724	Aug. 17	13	1	8.4	.7	1.3	.9	58.93	1.081	1.51	15.64	4.08	....
790	Aug. 22	14	1	9.3	.7	1.5	.8	79.48	1.076	1.56	14.72	3.00	....
875	Aug. 26	15	1	7.7	.8	1.7	1.1	60.19	1.081	1.34	15.77	2.45	....
929	Aug. 31	16	1	7.8	.7	1.5	1.0	59.49	1.079	1.19	15.98	2.75	....
985	Sept. 2	17	1	9.0	.8	1.6	1.2	60.00	1.074	1.17	15.25	3.60	14.04
1042	Sept. 5	17	1	8.5	.7	1.7	1.2	58.47	1.083	1.03	17.67	2.92	16.83
1100	Sept. 9	18	1	7.8	.8	1.9	1.2	57.33	1.077	1.38	15.90	2.60	....
1193	Sept. 15	18	1	7.6	.8	1.6	.9	62.83	1.066	1.87	11.52	5.04	....
1349	Oct. 4	After 18	1	8.3	.7	1.6	1.0	56.92	1.072	1.59	13.55	2.89	12.41

HOLCUS SACCHARATUS.

VILMORIN.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
127	July 13	1	1	5.0	.8	1.2	1.0	64.12	1.016	1.03	.56	2.79	....
218	July 16	2	1	6.0	.7	.8	.6	72.98	1.020	2.88	....	2.95	....
319	July 22	3	1	9.5	.8	1.0	1.2	66.97	1.025	1.82	1.76	3.34	....
537	Aug. 3	4	1	9.7	.9	1.6	1.1	56.27	1.032	1.27	2.81	4.01	....
646	Aug. 12	5	2	8.7	.8	1.1	.8	48.17	1.038	2.10	3.84	2.21	....
650	Aug. 12	6	1	9.5	.7	.7	.5	41.86	1.037	2.59	2.82	4.47	3.02
651	Aug. 12	7	1	9.7	.8	.8	.6	42.72	1.038	2.76	3.18	4.28	....
725	Aug. 17	8	1	10.2	.8	1.2	.8	50.38	1.056	2.48	7.64	3.46	5.61
800	Aug. 22	9	2	9.3	.7	1.7	1.1	42.91	1.057	2.27	7.95	3.73	6.99
876	Aug. 26	10	1	8.0	.6	1.0	.7	44.44	1.051	2.10	7.23	3.27	5.55
930	Aug. 31	11	1	9.1	.9	1.4	.9	44.55	1.047	1.57	5.53	4.83	....
986	Sept. 2	12	1	10.1	1.0	1.5	1.0	46.42	1.042	.87	3.87	5.58	3.981
1043	Sept. 5	13	1	10.4	.8	1.2	.8	48.10	1.046	1.55	4.72	4.81	3.81
1106	Sept. 10	14	1	10.5	.9	1.0	.7	48.48	1.046	1.37	4.88	5.27	4.56
1194	Sept. 15	15	1	8.4	.8	.9	.6	47.93	1.051	1.49	5.69	10.54	....
1363	Oct. 5	After 18	1	8.3	.7	.9	.6	44.82	1.058	.53	7.81	4.37	....

HOLCUS SORGHUM.

VILMORIN.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
28	July 6	....	3	5.0	.8	3.4	2.5	64.79	1.016	1.35	....	2.68	....
74	July 9	....	1	7.0	.8	1.5	1.1	61.49	1.018	.81	.91	2.25	....
195	July 16	1	1	7.0	.7	.9	.6	56.95	1.020	1.04	1.18	3.17	....
128	July 13	2	1	7.7	.7	1.1	.8	52.09	1.018	.67	.38	2.97	....
219	July 16	3	1	7.5	.7	1.1	.8	59.67	1.020	1.04	.46	3.81	....
243	July 18	4	1	8.5	.8	1.1	.8	63.66	1.020	3.55	....	1.35	....
269	July 19	5	1	10.0	.8	1.2	1.0	56.29	1.025	1.03	1.62	3.20	....
285	July 20	6	1	9.0	.8	1.5	1.1	47.29	1.021	1.04	....	1.04	....
315	July 22	6	1	10.8	.8	1.3	.9	47.44	1.022	.84	1.46	2.78	....
460	July 29	7	1	11.9	.7	1.1	.7	50.29	1.031	1.45	3.57	5.51	3.16
588	Aug. 3	7	1	11.1	.6	.9	.6	44.64	1.034	.96	3.37	4.22	....
647	Aug. 12	8	1	11.7	.7	1.9	1.3	48.60	1.034	1.51	2.94	3.96	....
726	Aug. 17	9	1	10.2	.7	1.0	.5	43.67	1.044	1.00	5.32	4.16	3.87
801	Aug. 23	10	2	12.3	.9	2.0	1.5	43.89	1.042	.81	4.24	4.31	3.79
877	Aug. 27	11	1	11.4	.8	1.3	.9	36.66	1.031	.87	3.08	3.81	2.29
931	Aug. 31	12	2	11.0	.5	1.1	.8	34.98	1.064	.92	10.17	4.13	....
987	Sept. 2	13	2	11.6	.7	1.7	1.3	38.27	1.058	.87	8.82	6.28	8.32
1044	Sept. 5	14	1	11.1	.9	1.1	.9	51.13	1.064	.90	11.04	4.69	....
1107	Sept. 10	15	1	12.0	.8	1.1	.9	41.95	1.057	.82	8.77	5.07	8.62
1195	Sept. 15	16	1	11.5	.8	.8	.7	47.75	1.044	.81	4.14	6.06	....
1364	Oct. 5	After 18	3	11.0	.7	1.9	1.2	35.01	1.038	.05	3.18	4.04	6.82

HOLCUS CERNUS, WHITE.

VILMORIN.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
29	July 6	....	3	4.5	.8	3.6	2.7	59.91	1.016	1.07	.37	2.44	....
220	July 18	1	1	8.0	.6	1.1	.8	50.56	1.027	.85	2.05	2.51	....
75	July 11	2	1	6.0	1.2	2.1	1.7	50.90	1.018	1.84	....	2.28	....
129	July 13	2	1	8.0	.9	1.9	1.3	58.00	1.019	.52	.53	3.75	....
286	July 20	3	1	9.3	.9	2.1	1.6	61.64	1.023	1.16	....	1.16	....
324	July 22	3	1	6.8	.6	1.0	.6	45.82	1.029	1.62	2.37	3.10	....
394	July 26	4	1	9.9	.9	2.1	1.3	54.63	1.030	.98	2.72	3.19	....
589	Aug. 3	5	1	9.6	.8	1.4	.9	44.36	1.056	1.65	7.67	4.26	....
648	Aug. 12	6	1	10.3	.8	1.9	1.2	41.34	1.047	1.64	6.14	4.44	5.80
653	Aug. 12	7	1	10.5	.8	2.2	1.6	48.30	1.047	1.85	5.96	4.51	1.94
654	Aug. 12	8	1	10.5	1.0	2.1	1.5	53.38	1.052	.77	7.74	4.60	7.06
727	Aug. 17	9	1	10.0	.8	2.3	1.5	47.96	1.063	.99	10.39	5.13	....
802	Aug. 23	10	1	10.5	.9	2.5	1.6	49.51	1.055	.60	9.34	3.56	....
878	Aug. 27	11	1	10.8	1.1	3.7	2.1	50.10	1.062	.94	10.28	5.89	10.26
932	Aug. 31	12	1	10.0	.9	2.3	1.6	34.49	1.070	1.16	12.16	5.13	....
988	Sept. 2	13	1	10.0	1.0	2.6	1.6	49.29	1.075	.62	14.58	4.24	....
1049	Sept. 7	14	1	10.0	.7	1.3	.9	32.36	1.073	.99	12.57	4.19	....
1108	Sept. 10	15	1	10.0	.7	1.3	.8	33.88	1.074	2.53	11.96	4.88	....
1218	Sept. 17	17	1	8.2	.8	1.7	1.0	45.27	1.075	.68	13.61	4.31	....
1365	Oct. 5	After 18	1	8.8	.9	1.6	1.1	57.27	1.062	.47	11.49	4.89	....

HONEY CANE.

J. H. CLARK.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
130	July 18	1	1	5.5	1.0	1.7	1.4	71.39	1.016	1.78	....	2.45	....
573	Aug. 6	2	1	8.0	.9	2.6	2.0	68.21	1.030	4.61	2.53	1.16	1.78
574	Aug. 6	3	1	10.0	.8	2.2	1.7	71.44	1.029	4.61	2.38	1.13	1.31
649	Aug. 12	4	1	10.5	.8	1.8	1.5	72.28	1.035	5.19	2.64	2.50	1.85
652	Aug. 12	5	1	10.6	.9	2.2	1.8	71.70	1.039	5.89	2.63	2.30	5.45
728	Aug. 17	6	1	11.4	1.0	2.7	2.1	71.23	1.050	4.17	7.30	1.19	6.26
803	Aug. 23	7	1	12.0	.9	2.6	2.1	66.31	1.055	4.42	8.42	2.04	....
810	Aug. 23	7	......	......	......	......	......	....	1.058	4.52	8.26	2.15	7.90
879	Aug. 27	8	1	11.0	.9	3.2	2.5	66.13	1.049	3.49	6.10	4.18	6.87
890	Aug. 27	8	......	......	......	......	......	....	1.049	3.49	6.48	3.70	6.49
933	Aug. 31	9	1	11.0	.5	1.4	1.1	71.94	1.052	4.47	7.08	2.51	6.66
989	Sept. 2	10	1	10.0	.8	1.6	1.2	66.54	1.061	5.49	9.02	2.36	7.90
1050	Sept. 7	11	1	10.5	.9	2.1	1.8	69.64	1.059	5.19	8.07	1.92	7.41
1068	Sept. 7	11	......	......	......	......	......	....	1.059	5.19	8.97	1.04	7.34
1109	Sept. 10	12	1	11.3	.9	2.1	1.9	69.03	1.055	5.08	6.97	2.32	5.95
1219	Sept. 17	17	1	10.0	.8	2.3	2.0	61.62	1.070	2.83	12.67	2.09	12.59
1366	Oct. 5	After 18	1	11.5	.8	2.2	1.6	57.62	1.065	1.64	11.95	2.09	10.95

EGYPTIAN SUGAR CORN.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
2	June 13	....	8	2.5	.8	......	......	67.30	1.016	.94	.25	1.93	....
5	June 20	1	5	2.8	1.1	......	......	69.10	1.014	1.17	.47	1.52	....
9	June 27	2	3	2.9	1.0	......	......	78.10	1.015	2.20	.16	1.81	....
13	July 5	3	1	5.2	.8	2.1	1.5	68.78	1.017	2.52	.05	......	....
152	July 14	3	1	7.3	.7	1.2	.8	64.86	1.019	2.14	.69	2.81	....
198	July 16	4	1	7.5	.8	1.5	1.0	64.07	1.019	1.32	.74	4.90	....
78	July 11	5	1	7.5	1.1	2.8	1.7	66.96	1.021	2.88	.81	2.19	....
244	July 18	6	1	10.0	1.2	2.4	1.5	64.56	1.027	2.49	2.12	2.80	....
245	July 18	7	1	8.0	1.2	2.2	1.4	63.67	1.025	3.29	.89	1.88	....
287	July 20	8	1	9.4	1.1	2.4	1.3	68.57	1.026	2.92	....	2.92	....
290	July 21	8	1	8.8	.8	1.6	.8	62.28	1.029	2.50	3.97	3.05	....
316	July 22	8	1	10.0	1.1	2.5	1.4	60.64	1.037	3.39	4.09	2.74	....
366	July 25	9	1	9.5	1.2	2.6	1.4	60.20	1.034	2.67	5.07	1.64	....
371	July 25	9	......	......	......	......	......	....	1.035	2.61	3.76	2.08	....
372	July 26	10	1	10.0	1.4	3.6	1.8	62.95	1.039	3.07	5.07	2.01	....
481	Aug. 1	11	1	10.0	1.0	2.3	1.8	59.27	1.050	3.21	7.69	2.81	7.32
575	Aug. 6	11	1	8.0	.8	2.0	.9	63.26	1.036	4.17	8.94	2.12	8.28
586	Aug. 8	12	1	9.2	1.1	2.1	1.0	64.33	1.034	3.22	8.85	2.89	8.66
597	Aug. 9	11	1	9.3	.9	2.1	1.1	61.81	1.043	3.56	5.73	1.73	5.61
659	Aug. 13	13	1	9.1	1.1	2.6	1.1	57.46	1.039	2.41	5.71	1.07	....
729	Aug. 17	13	1	9.5	1.0	2.3	1.2	57.00	1.038	3.50	4.34	1.99	5.18
805	Aug. 23	14	2	9.0	.9	3.3	1.7	53.99	1.053	2.19	9.27	2.08	7.92
880	Aug. 27	15	1	8.2	1.0	1.8	1.1	58.38	1.062	2.40	11.02	4.14	10.98
984	Aug. 31	16	1	9.2	1.3	2.1	1.3	54.71	1.040	2.74	4.72	3.11	....
990	Sept. 2	17	1	9.0	1.0	1.5	1.0	57.30	1.061	2.59	12.80	1.95	10.84
1051	Sept. 7	17	1	8.0	1.0	1.6	1.3	54.85	1.073	1.73	13.59	2.19	....
1110	Sept. 10	18	1	9.3	.9	1.3	.9	53.68	1.047	2.50	7.58	1.05	....

EGYPTIAN SUGAR CORN.

Analysis made after the ears of corn had been plucked.

Number of analysis.	Date.	Number of days after stripping off ears.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
				Feet.	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
597	Aug. 9	0	1	9.3	.9	2.1	1.1	61.81	1.043	3.56	5.73	1.73	5.61
758	Aug. 18	7	1	11.0	1.1	1.8	1.4	60.16	1.055	3.24	7.60	2.38	3.87?
759	Aug. 18	7	1	9.5	1.1	1.8	1.4	60.60	1.047	2.98	7.46	1.92	7.54
814	Aug. 23	14	2	9.5	1.2	2.7	2.3	63.88	1.049	2.82	8.13	1.92	7.28
815	Aug. 23	14	2	9.0	1.1	2.3	2.0	55.35	1.050	3.45	7.24	2.45	7.34
922	Aug. 30	21	1	9.0	1.1	1.3	1.2	56.57	1.053	1.66	9.69	Lost	10.04
923	Aug. 30	21	1	8.2	1.0	1.5	1.3	61.19	1.057	1.89	10.33	Lost	8.96
965	Sept. 1	21	1	7.8	1.0	1.3	1.0	60.00	1.061	1.76	12.57	1.03	....
966	Sept. 1	21	1	7.6	1.1	1.5	1.1	59.02	1.060	2.18	11.20	2.18	10.39
972	Sept. 1	21	......	......	......	......	......	....	1.061	2.46	11.17	1.63	10.49
1045	Sept. 5	28	1	9.4	1.1	1.1	.8	50.14	1.071	5.41	9.91	3.35	....
1046	Sept. 5	28	2	9.0	.9	1.5	1.3	51.12	1.060	3.85	9.10	2.61	....
1077	Sept. 8	28	2	8.0	1.1	1.8	1.5	51.79	1.065	2.26	11.73	2.20	11.40
1078	Sept. 8	28	2	9.0	1.0	1.8	1.5	55.21	1.059	2.57	11.84	1.19	10.55

LINDSAY'S HORSE TOOTH.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
3	June 13	....	6	2.8	1.0	......	......	58.70	1.016	.98	.38	1.65	....
6	June 20	....	4	3.2	1.2	......	......	73.40	1.015	1.17	.47	1.46	....
199	July 16	1	1	6.0	.8	1.1	.7	65.62	1.024	2.66	.92	2.42	....
10	June 27	....	3	4.4	1.1	......	......	76.40	1.017	2.12	.20	1.41	....
200	July 16	2	1	7.0	.9	1.9	1.3	65.67	1.023	3.85	.76	2.37	....
14	July 5	....	1	5.5	1.5	3.8	2.8	67.32	1.018	2.27	.17	1.63	....
153	July 14	3	1	8.7	1.4	4.0	2.9	67.61	1.020	2.30	.58	2.71	....
201	July 16	4	1	6.5	1.0	1.3	.9	57.50	1.029	3.28	2.05	2.24	....
79	July 11	5	1	5.7	1.3	3.3	2.4	68.09	1.018	2.03	.47	2.46	....
246	July 18	6	1	11.3	1.4	3.7	2.7	74.30	1.025	2.70	.90	1.86	....
288	July 20	7	1	10.0	1.1	2.4	1.8	66.76	1.028	2.79	.11	2.90	....
317	July 22	7	1	9.9	1.2	2.5	1.6	66.85	1.024	2.50	1.43	2.96	....
291	July 21	8	1	10.3	1.1	2.2	1.5	68.56	1.024	2.36	2.08	2.63	....
367	July 25	9	1	11.0	1.2	3.0	1.7	66.45	1.030	3.06	3.28	2.20	....
373	July 26	9	1	11.0	1.2	3.4	2.2	64.34	1.030	2.61	10.67	......	....
484	Aug. 1	10	1	10.5	.8	2.6	1.5	58.04	1.050	2.51	7.85	3.44	7.44
482	Aug. 1	11	1	11.5	1.0	3.6	1.7	62.87	1.040	2.94	5.11	2.52	4.57
576	Aug. 6	11	1	11.9	1.1	3.7	1.8	56.85	1.041	2.76	5.57	2.81	[illegible]
587	Aug. 8	12	1	11.1	1.1	3.5	2.0	62.29	1.040	2.70	4.36	3.51	4.34
660	Aug. 13	13	1	10.9	1.1	4.1	2.3	62.90	1.046	2.54	7.47	2.51	6.96
751	Aug. 18	13	1	10.3	1.2	3.7	1.9	58.95	1.041	2.23	6.66	1.43	5.57
806	Aug. 23	14	2	10.5	1.0	4.4	2.2	54.56	1.042	3.02	6.13	1.59	5.99
881	Aug. 27	15	1	10.3	1.3	3.2	1.7	60.50	1.041	2.98	4.81	2.46	4.61
835	Aug. 31	16	1	10.1	1.0	2.4	1.5	50.09	1.050	3.09	7.19	2.67	7.04
991	Sept. 2	17	1	8.9	1.4	2.7	2.1	61.48	1.056	1.53	12.25	1.77	8.53
1052	Sept. 7	17	1	11.0	1.1	2.2	.9	50.45	1.032	.77	2.36?	3.96	....
1111	Sept. 10	18	1	10.8	1.1	2.8	1.9	50.91	1.061	1.60	11.57	2.54	10.49

BLOUNT'S PROLIFIC.

82	July 7	....	1	8.5	1.3	3.7	2.5	67.31	1.017	1.75	.53	2.53	....
131	July 13	1	1	7.5	1.1	2.8	1.7	56.37	1.018	1.48	.26	3.18	....
202	July 16	2	1	5.5	.6	.9	.6	68.09	1.020	2.79	.16	4.55	....
154	July 14	3	1	9.8	.9	2.4	1.6	58.75	1.023	2.26	1.06	2.57	....
289	July 20	4	1	9.0	.9	2.0	1.4	65.44	1.021	2.05	....	3.58	....
318	July 22	4	1	8.2	.7	1.2	.8	58.87	1.028	3.77	1.27	2.06	....
292	July 21	5	1	10.4	1.2	2.6	1.7	63.80	1.024	2.50	1.73	2.99	....
293	July 21	6	1	9.8	.8	1.3	.9	67.90	1.029	3.82	2.46	2.27	....
294	July 21	7	1	9.5	.9	2.1	1.1	64.84	1.027	2.61	1.96	3.65	....
368	July 25	8	1	10.0	.8	1.9	.9	65.37	1.029	1.50	2.93	2.47	....
374	July 26	9	1	10.5	1.0	2.8	1.5	59.85	1.037	2.55	4.87	2.50	....
483	Aug. 1	10	1	10.8	1.0	2.0	1.2	55.78	1.042	3.53	5.49	2.50	4.95
500	Aug. 1	10	......	......	......	......	......	....	1.045	3.24	6.27	2.21	5.27
577	Aug. 6	11	1	10.0	.9	2.4	1.0	51.18	1.044	2.28	6.94	2.27	5.90
589	Aug. 9	11	1	10.3	1.0	2.3	.9	49.62	1.029	2.84	2.97	1.52	2.97
661	Aug. 13	12	1	10.6	1.0	3.0	1.3	57.39	1.033	2.35	3.63	2.49	3.11
752	Aug. 18	12	1	10.5	.8	2.2	.8	45.02	1.037	1.92	4.34	3.86	4.35
807	Aug. 23	13	2	10.5	.9	3.4	2.0	51.84	1.048	1.63	7.91	2.28	4.87
882	Aug. 27	14	1	9.5	1.0	1.8	1.0	57.47	1.045	1.90	7.16	4.33	6.67
936	Aug. 31	15	1	11.0	1.3	2.0	1.1	52.52	1.028	.69	1.91?	4.06	....
992	Sept. 2	16	1	11.0	1.2	1.9	1.2	42.62	1.027	.70	2.35	2.66	....
1053	Sept. 7	17	1	10.0	1.0	1.1	.9	55.22	1.051	1.36	8.40	2.89	6.06
1112	Sept. 10	18	1	9.5	1.1	1.7	1.0	49.67	1.041	1.92	6.95	3.13	7.15

IMPROVED PROLIFIC BREAD.

83	July 7	1	1	5.0	1.3	2.6	1.9	71.09	1.016	2.15	.28	2.24	....
132	July 13	1	1	8.2	1.1	3.3	2.4	60.72	1.017	1.67	.18	2.23	....
155	July 15	2	1	7.5	1.2	3.3	2.5	62.34	1.020	1.83	.42	3.14	....
247	July 18	3	1	10.0	1.2	2.5	1.6	70.06	1.024	2.44	.90	2.63	....
295	July 21	4	1	10.4	1.4	3.6	2.7	63.35	1.024	2.86	1.61	2.61	....
296	July 21	5	1	10.0	1.2	3.1	2.3	67.59	1.022	2.99	.74	2.14	....
369	July 25	5	1	8.7	.9	1.9	1.2	60.49	1.030	2.92	2.12	2.43	....
375	July 26	6	1	10.0	1.0	2.8	2.0	61.63	1.033	3.87	1.77	2.87	14

IMPROVED PROLIFIC BREAD—Continued.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inchs.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
376	July 26	7	1	10.4	1.1	3.3	2.0	61.39	1.029	2.44	2.31	2.68	2.16
485	Aug. 1	8	1	11.5	1.2	3.2	2.1	65.74	1.038	2.53	4.92	2.90	4.25
493	Aug. 1	8	......	......	......	......	......	......	1.037	2.53	4.58	2.72	4.15
590	Aug. 9	9	2	11.9	1.1	7.2	4.2	57.89	1.049	2.68	7.58	1.65	7.02
662	Aug. 13	12	1	12.1	1.0	4.3	2.1	56.60	1.047	2.32	7.32	−1.58	7.30
753	Aug. 18	12	1	11.0	.9	3.2	1.7	59.48	1.039	2.08	5.09	2.18	4.50
808	Aug. 23	10	1	8.7	.8	1.4	.9	52.56	1.045	3.76	5.20	2.52	7.01
809	Aug. 23	11	2	9.0	.8	3.0	2.2	61.60	1.043	1.33	4.01	5.11	5.10
804	Aug. 23	13	......	......	......	......	......	......	1.040	2.28	5.20	2.33	8.09?
811	Aug. 23	13	1	12.0	1.1	4.0	2.0	62.36	1.040	2.42	5.16	2.51	4.73
883	Aug. 27	14	1	11.3	1.0	4.0	2.0	60.30	1.044	2.32	7.44	2.55	6.63
891	Aug. 27	14	......	......	......	......	......	......	1.044	2.39	7.28	2.41	6.66
937	Aug. 31	15	1	11.0	1.0	2.0	1.5	40.06	1.035	2.05	4.79	1.95	......
993	Sept. 2	16	1	10.7	1.0	2.2	1.3	51.49	1.035	2.05	4.29	2.83	3.96
1054	Sept. 7	17	1	10.5	1.1	2.5	1.3	63.18	1.041	1.92	6.50	2.00	......
1113	Sept. 10	18	1	11.2	1.1	2.3	1.3	54.95	1.031	1.61	3.31	2.54	2.08

BROAD WHITE FLAT DENT.

24	July 7	1	1	5.0	1.0	2.2	1.6	63.92	1.018	2.54	.18	2.19	......
133	July 13	1	1	8.0	1.3	3.0	2.2	67.09	1.021	2.44	.34	1.26	......
156	July 15	2	1	7.1	1.0	2.4	1.7	66.79	1.023	2.50	.59	2.18	......
297	July 21	3	1	7.5	1.1	2.4	1.6	58.69	1.025	3.29	1.16	2.67	......
298	July 21	4	1	8.1	1.1	2.3	1.6	61.56	1.025	3.11	1.04	2.97	......
299	July 21	5	1	8.6	1.3	3.1	2.1	63.18	1.030	4.28	1.91	2.07	......
370	July 25	5	1	8.5	1.2	2.3	1.6	77.81	1.025	2.38	.83	3.42	......
377	July 26	6	1	9.0	1.1	1.8	1.2	59.61	1.029	3.59	1.47	2.81	1.27
378	July 26	7	1	9.3	1.0	2.7	1.9	66.93	1.036	3.74	3.12	2.02	2.83
487	Aug. 1	8	1	11.0	1.0	2.9	1.8	59.46	1.040	3.66	4.29	2.62	3.75
592	Aug. 9	9	1	10.2	1.1	3.0	1.9	59.97	1.055	2.25	9.97	1.33	8.14
663	Aug. 13	10	1	10.7	1.4	4.1	2.3	......	1.045	2.24	6.27	3.16	6.31
754	Aug. 18	10	1	10.3	1.0	2.3	1.3	54.25	1.035	2.98	3.03	3.02	2.95
812	Aug. 23	11	1	11.4	1.1	2.5	1.7	60.39	1.044	3.53	4.30	3.04	4.36
884	Aug. 27	12	1	10.6	1.3	4.4	2.1	54.06	1.040	Lost.	......	......	4.94
938	Aug. 31	12	1	10.8	1.2	1.7	1.1	71.39	1.054	2.92	7.64	3.86	7.32
994	Sept. 2	13	1	12.5	1.1	2.6	1.9	51.40	1.055	2.84	9.97	2.26	8.73
1055	Sept. 7	14	1	10.5	1.0	1.8	1.2	51.47	1.069	2.25	12.55	2.50	11.74
1114	Sept. 10	15	1	11.0	1.1	2.2	1.2	47.03	1.030	1.15	3.53?	2.89	3.24

LONG NARROW WHITE DENT.

25	July 7	1	1	4.3	1.3	2.7	2.0	68.84	1.019	2.21	.23	1.71	......
157	July 15	2	1	7.6	1.0	1.9	1.4	60.27	1.024	2.41	1.83	3.96	......
300	July 21	3	1	7.0	.8	1.5	1.0	65.97	1.029	3.54	1.43	2.56	......
301	July 21	4	1	7.8	.8	1.8	1.2	65.37	1.026	3.27	1.04	3.29	......
302	July 21	5	1	7.8	1.1	2.4	1.6	60.27	1.023	3.48	1.60	2.34	......
379	July 26	6	1	9.7	1.1	1.9	1.3	60.96	1.032	3.15	3.56	2.10	2.80
380	July 26	7	1	9.5	1.2	2.2	1.4	56.83	1.033	3.69	3.05	2.16	......
486	Aug. 1	8	......	......	......	......	......	......	1.045	3.56	5.34	3.10	......
488	Aug. 1	8	1	10.0	1.1	3.7	1.9	63.77	1.046	3.16	5.81	3.12	5.36
593	Aug. 9	9	1	10.3	1.1	3.2	1.9	56.96	1.041	4.50	4.40	1.47	3.65
655	Aug. 12	10	1	10.2	1.1	3.6	1.6	59.70	1.053	4.41	8.32	2.27	8.03
755	Aug. 18	11	1	10.4	1.1	4.0	1.7	62.77	1.049	2.58	6.90	2.48	7.03
813	Aug. 23	12	1	9.2	1.5	4.5	2.8	62.34	1.059	1.97	10.67	2.32	10.49
816	Aug. 24	13	1	10.6	1.2	2.7	1.8	53.58	1.048	2.53	7.34	2.25	......
847	Aug. 26	13	1	9.8	1.2	4.3	2.1	52.05	1.062	2.36	11.62	1.98	11.51
857	Aug. 26	13	......	......	......	......	......	......	1.062	2.36	11.74	1.90	11.63
895	Aug. 27	14	1	9.5	1.1	3.3	1.7	57.73	1.048	3.16	7.59	2.75	7.28
939	Aug. 31	15	1	10.0	1.4	3.4	1.6	53.55	1.042	1.55	5.20	3.99	5.26
953	Aug. 31	15	......	......	......	......	......	......	1.042	1.61	5.42	3.62	......
995	Sept. 2	16	1	9.5	1.0	2.2	1.4	45.95	1.056	3.25	9.51	3.24	9.39
1056	Sept. 7	17	1	9.8	.9	1.5	1.1	56.00	1.065	1.84	12.11	2.52	3.81?
1115	Sept. 10	18	1	10.5	1.8	3.8	2.5	55.47	1.058	2.56	10.59	2.06	10.20
1122	Sept. 10	18	......	......	......	......	......	......	1.058	2.51	10.30	2.31	10.29

CHESTER COUNTY MAMMOTH.

Number of analysis.	Date.	Development.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar.	Polarization.
		Stage.		*Feet.*	*Inches*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
36	July 7	1	1	5.1	1.3	2.7	1.9	63.81	1.021	3.34	.64	1.99	....
134	July 13	1	1	6.0	1.2	2.7	1.9	55.50	1.020	4.16	.85	2.40	....
158	July 15	2	1	6.0	1.6	3.7	3.0	71.76	1.022	2.97	.72	2.91	....
159	July 15	3	1	7.0	1.0	2.6	1.8	60.84	1.022	3.85	.16	3.81	....
160	July 15	4	1	7.0	1.0	2.1	1.3	56.24	1.032	3.81	2.00	3.73	....
161	July 15	5	1	10.0	1.8	3.9	2.0	57.67	1.025	2.74	1.41	4.68	....
248	July 18	6	1	9.0	1.4	3.5	1.8	61.68	1.038	3.17	3.22	2.82	....
303	July 21	7	1	10.8	1.1	2.3	1.4	55.96	1.034	3.74	2.13	3.33	....
304	July 21	8	1	9.8	1.4	2.8	1.7	57.14	1.035	3.32	4.63	3.20	....
489	Aug. 1	8	1	8.7	1.8	4.2	1.9	58.89	1.039	2.11	5.64	3.07	....
490	Aug. 1	8	....	......	......	......	......	....	1.039	2.18	5.92	2.23	5.71
381	July 26	9	1	8.1	1.2	2.3	1.2	56.04	1.050	2.64	7.76	1.65	....
382	July 26	10	1	9.8	.9	2.8	1.0	59.55	1.049	2.92	8.24	1.99	....
594	Aug. 9	11	1	8.9	1.0	3.1	1.4	54.62	1.041	3.24	6.16	.73	5.25
656	Aug. 12	12	1	8.2	1.2	3.8	1.3	57.01	1.041	2.40	5.82	2.92	5.54
756	Aug. 18	13	1	8.5	1.0	2.5	1.0	52.41	1.039	3.36	5.12	1.75	4.89
817	Aug. 24	14	1	9.5	1.8	2.8	1.3	55.81	1.029	1.25	2.47	3.08	2.26
848	Aug. 26	15	1	9.0	1.2	3.3	1.2	53.14	1.064	1.29	12.94	1.88	12.37
886	Aug. 27	15	1	8.0	1.0	2.6	.8	57.49	1.036	2.31	3.71	4.45	....
940	Aug. 31	16	1	8.5	1.2	1.8	.5	41.66	1.036	1.32	3.78	4.16	....
996	Sept. 2	17	1	10.0	.9	1.7	1.4	53.11	1.067	1.44	13.88	2.86	....
1057	Sept. 7	17	1	10.3	1.0	1.2	.8	52.08	1.035	1.50	3.99?	2.86	....
1116	Sept. 10	18	1	10.0	1.2	2.2	1.5	46.77	1.039	1.44	5.94	2.43	5.20

EIGHTEEN-ROWED YELLOW DENT.

37	July 7	1	1	5.2	1.3	3.3	2.4	65.36	1.022	3.58	.35	1.79	....
162	July 15	2	1	6.0	1.1	1.8	1.2	62.88	1.023	3.64	.48	3.21	....
163	July 15	3	1	5.5	1.3	2.8	1.9	62.82	1.023	2.86	.65	4.89	....
249	July 18	4	1	8.0	1.3	3.0	1.6	63.47	1.028	2.49	1.89	5.34	....
305	July 21	5	1	7.6	1.0	1.9	1.3	62.84	1.028	3.36	1.57	2.83	....
306	July 21	6	1	6.5	1.1	2.0	1.2	60.17	1.031	4.21	2.07	2.98	....
307	July 21	7	1	8.1	1.2	2.3	1.5	60.09	1.028	3.95	2.23	2.67	....
383	July 26	8	1	9.2	1.2	2.6	1.5	61.03	1.032	3.96	3.36	1.40	....
491	Aug. 1	9	1	8.5	1.1	3.5	1.7	60.62	1.043	3.65	5.17	2.92	....
595	Aug. 9	10	2	8.5	1.1	5.8	2.4	54.82	1.044	3.05	6.87	1.88	6.40
657	Aug. 12	11	1	10.2	1.3	4.2	2.0	54.90	1.052	3.20	8.24	2.81	7.58
757	Aug. 18	12	1	8.5	1.3	3.7	1.3	55.40	1.036	3.35	4.15	2.06	7.46?
818	Aug. 24	13	1	10.2	1.6	4.3	2.3	58.44	1.050	1.50	9.20	1.81	8.56
824	Aug. 24	13	....	......	......	......	......	....	1.049	1.46	13.60	—2.48	8.69
849	Aug. 26	13	1	10.0	1.4	3.4	2.2	49.80	1.060	1.32	11.56	2.54	10.77
861	Aug. 26	13	....	......	......	......	......	....	1.061	1.53	11.48	2.07	10.76
887	Aug. 27	14	1	7.7	1.1	2.8	1.4	59.38	1.051	2.80	8.13	3.39	8.34
941	Aug. 31	15	1	9.0	1.3	2.3	1.2	49.64	1.045	3.22	6.18	2.56	....
1003	Sept. 3	16	1	8.1	1.3	2.1	1.5	50.00	1.062	2.11	11.39	5.=0?	11.44
1058	Sept. 7	17	1	9.0	1.2	2.3	.7	37.94	1.030	1.20	4.35?	2.12	....
1117	Sept. 10	18	1	9.7	1.6	3.1	1.9	63.53	1.057	1.56	11.79	2.78	10.86
1121	Sept. 10	18	....	......	......	......	......	....	1.057	1.59	11.52	2.50	10.84

In the following tables are given the average of the determinations for each stage of development for each variety.

In addition to the columns giving the average results of the several determinations given in the preceding tables, there is given a column showing what is termed the percentage of available sugar present in the juice, *i. e.*, the amount of sugar which may be obtained as sugar from the juice, for, as is generally known, the amount of sugar to be obtained from any given specimen of juice depends obviously upon the amount of sugar present; but not alone upon this, but also upon the amount of glucose, and other matters present, since, as is well known, the effect of these is to prevent the crystallization of a portion of the sugar present, and, hence, to increase the relative amount of molasses, the molasses consisting of glucose, water, mineral matters (the ash), and more or less sugar, which practically cannot be recovered as such. Now this molasses-producing (melassigenic) property of the several impurities present in the juices of cane, sorghum, and beets has been a subject of considerable experiment, but at the present time the exact effect of each impurity is not known.

The average of thirty-four analyses of sorghum juices, made in this laboratory, shows an average percentage of ash equal to 1.06; the maximum being 1.66 per cent. and the minimum being .82 per cent. We may, then, safely estimate the ash as being about one per cent. of the juice.

Now, while all authorities are agreed as to the melassigenic effect of certain of the mineral constituents of the ash, there is much difference as to the action of other mineral matters, and while some of these are regarded as quite indifferent in their action, other constituents of the ash are shown to strongly favor the crystallization of the sugar. For example, potassium carbonate increases the quantity of molasses produced, potassium sulphate appears to have no effect, while magnesium sulphate seems to favor the crystallization of sugar, and thus decrease the amount of molasses.

It is highly probable that much of the good effect attributed to the use of sulphurous acid, as an aid in the crystallization of sirups, is due to the fact that it converts the harmful alkaline carbonates into the inert sulphates. In the report of our work last year we, in accordance with a common practice among sugar-makers, made use of the so-called "exponent," which represented the relative purity of the different juices. This "exponent" was the percentage of sucrose in the total solids of the juice; and this represented the percentage of the sugar present in the juice which could be in practice obtained as sugar. While this method of calculation is doubtless at least approximately correct when applied to those juices which are generally worked up for sugar, it is obviously erroneous when applied to juices poor in sugar and with comparatively large amounts of other solids.

We have, therefore, this year adopted a method for calculating the available sugar, viz.:—the difference between the per cent. of sucrose and the sum of the per cents of glucose and solids not sugar, and although confident that all the experiments of Marschall, La Grange, and others go to prove that the amount of available sugar thus shown is beyond question too low, it is at least safe to err upon this side rather than the other.

If we apply these two methods to two specimens of juice, one good and the other poor, it will be seen that for the good juice the two methods approximately agree, while for the poor juice they differ widely, and there is no doubt but that the method of the exponent is in such a case inapplicable; *e. g.*—

Juice A contains: sucrose, 3.51 per cent.; glucose, 4.50 per cent.; solids, 1.78 per cent. The exponent would be 35.85 and the available sugar 1.26 per cent.; or, by the other method, $3.51-(4.50+1.78)=-2.77$.

Juice B contains: sucrose, 15.30 per cent.; glucose, .87 per cent.; solids, 2.95 per cent. The exponent would be 80.02 and the available sugar 12.24 per cent.; or, by the other method, $15.30-(.87+2.95)=11.48$ per cent.

It is from the above assumed cases obvious that the last method of calculation, although giving probably too low a result, is one of general application, since no one would regard it as possible practically to obtain any sugar from a juice having the composition of the one marked A.

It will be observed that in the tables the available sugar begins to show itself quite late in the development of the plant, generally about the seventh or eighth stage, and it is obvious that previous to this period the available sugar exists, as we may say, as a minus quantity; but owing to the practical importance of this matter its discussion will be again taken up.

It will also be observed that the dates of analysis do not correspond exactly to the dates when the several varieties had reached the separate stages. This was owing to the rapid development of the plants, which proceeded more rapidly than the assistants in the labaratory were able to do with their daily examinations.

GRAPHICAL CHARTS.

The preceding results will appear more clearly by representing them, as was done last year, graphically, and in the following charts the percentage is indicated, for the sucrose, glucose, solids not sugars, and available sugar, by the numbers given upon the right and left hand margins, while the dates are given upon the upper margin of each sheet. For convenience of platting upon the same sheet, the per cent. of juice given upon the charts should be multiplied by five in every case, and the specific gravity is represented by having .001 in specific gravity equal to one-fifth of one per cent. as given upon the chart.

Each point indicated by a break in either of the lines representing the above constituents, the specific gravity or the juice, represents the average result actually obtained in the several analyses of a juice at any given stage of development. The beginning of each line and the end represent the average results of the first and last stages, and the intervening breaks the successive stages from the first to the last.

ANALYSES OF EACH VARIETY OF SORGHUM AND MAIZE IN DIFFERENT STAGES.

The following tables, prepared from the preceding, represent on separate tables the average results of the analyses of each variety in the several stages of development, each table containing only the analyses of a single stage, and the general average of all the analyses of all varieties at each separate stage is given. An examination will show that there is practical agreement in all these sorghums, the only difference being in the time from planting necessary for the different varieties to attain to any given stage.

EARLY AMBER.

CARLL AND GARDNER.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
1	July 1	July 1	2	1.73	.39	1.91	4.03	....	....	56.12	1.016
1	July 16	July 9	1	3.15	1.15	2.65	6.95	....	....	53.69	1.028
2	July 16	July 11	1	2.92	1.52	1.45	5.89	....	....	63.29	1.026
3	July 11	July 13	1	2.20	.58	4.10	6.88	....	....	70.85	1.021
4	July 14	July 15	2	2.78	.81	3.50	5.27	....	....	64.28	1.012
5	July 15	July 18	1	2.61	.09	2.80	6.40	....	....	68.80	1.023
6	July 20	July 19	1	3.17	3.10	2.42	8.69	....	....	68.23	1.047
7	July 23	July 20	1	3.54	4.83	3.63	12.00	....	....	65.79	1.041
8	July 28	July 25	1	3.57	3.53	3.27	10.37	....	....	65.81	1.036
9	July 26	July 27	3	2.73	7.62	2.29	12.64	7.41	2.60	66.46	1.047

EARLY AMBER—Continued.

Carll and Gardner—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
10	July 29	July 30	2	2.91	9.26	2.81	14.98	9.19	3.54	60.00	1.057
11	Aug. 1	Aug. 3	1	2.47	12.25	2.87	17.59	11.39	6.91	64.66	1.066
12	Aug. 8	Aug. 9	1	1.86	12.96	5.04	19.86	12.82	6.06	63.37	1.072
13	Aug. 13	Aug. 12	1	1.57	14.27	3.30	19.14	13.89	9.40	64.51	1.071
14	Aug. 18	Aug. 16	1	1.55	14.83	3.98	20.31	....	9.35	63.39	1.083
15	Aug. 26	Aug. 19	3	.95	16.08	2.97	21.44	....	12.11	58.45	1.085
16	Aug. 31	Aug. 26	1	1.09	18.43	3.27	22.79	....	14.07	52.77	1.091
17	Sept. 5	Sept. 3	2	.80	18.42	3.00	22.22	16.92	14.62	53.53	1.090
18	Sept. 13	Sept. 10	2	1.06	17.32	3.94	22.32	....	12.32	46.87	1.089
After 18....	Oct. 10	....	2	1.01	14.78	3.68	19.47	13.96	10.09	56.09	1.078
After 18	Oct. 20	....	1	1.27	14.23	3.50	19.00	17.01	9.46	56.13	1.076
After 18....	Oct. 30	....	4	1.01	13.75	4.15	18.91	13.76	8.49	59.16	1.076
After 18	Nov. 10	....	3	.85	13.94	3.69	18.48	13.95	9.40	51.12	1.075
After 18....	Nov. 17	....	2	1.20	13.65	3.22	18.07	14.09	9.23	54.69	1.074

EARLY GOLDEN.

A. B. Swain.

1	July 6	July 4	1	3.11	2.91	.90	6.92	....	....	66.99	1.026
2	July 16	July 6	1	3.10	1.36	2.40	6.86	....	....	69.68	1.027
3	July 8	July 8	1	3.17	1.58	3.16	7.91	....	....	71.33	1.023
4	July 13	July 9	2	2.46	1.54	2.00	6.01	....	....	67.03	1.021
5	July 13	July 11	2	2.62	1.69	4.10	8.42	....	....	68.85	1.024
6	July 14	July 14	1	2.95	4.04	3.67	10.66	....	....	68.01	1.036
7	July 18	July 18	1	3.00	5.25	1.17	9.42	....	1.08	66.39	1.040
8	July 19	July 25	1	2.97	5.42	1.17	9.56	....	1.18	69.57	1.046
9	July 26	July 27	4	2.38	9.26	2.80	14.50	9.84	4.08	67.12	1.056
10	July 28	July 30	2	2.48	11.14	1.60	15.22	10.27	7.06	66.95	1.061
11	Aug. 1	Aug. 3	1	1.76	13.84	2.91	18.51	13.08	9.17	64.26	1.072
12	Aug. 8	Aug. 9	1	1.38	14.64	4.96	20.93	14.22	8.35	60.76	1.075
13	Aug. 13	Aug. 12	1	1.16	14.57	4.02	19.75	....	9.39	64.31	1.078
14	Aug. 19	Aug. 16	1	1.69	14.48	2.67	18.84	....	10.12	58.50	1.077
15	Aug. 26	Aug. 19	3	1.55	15.36	3.65	20.56	....	10.16	59.14	1.082
16	Aug. 31	Aug. 26	1	1.26	18.08	3.78	23.07	....	13.09	63.42	1.090
17	Sept. 5	Sept. 3	2	.89	17.65	2.76	21.30	16.27	14.00	57.54	1.086
18	Sept. 13	Sept. 10	2	1.34	16.50	3.38	21.22	....	11.78	54.09	1.083
After 18	Oct. 10	....	2	1.28	13.84	3.14	18.26	....	9.42	54.55	1.074
After 18	Oct. 20	....	1	1.03	16.11	3.86	21.00	....	11.22	58.78	1.085
After 18	Oct. 30	....	4	1.10	14.43	3.85	19.38	15.41	9.48	55.27	1.078
After 18....	Nov. 10	....	3	1.33	12.99	3.84	18.16	12.70	7.82	55.71	1.073
After 18	Nov. 17	....	2	1.32	13.99	3.45	18.76	14.66	9.22	55.42	1.076

WHITE LIBERIAN.

Mr. Nesbit.

Before 1.....	July 6	July 1	1	2.88	4.31	......	6.27	....	....	68.00	1.020
1	July 16	July 3	1	2.96	1.20	.69	5.85	....	....	64.29	1.024
2	July 16	July 6	1	3.08	1.76	2.21	7.05	....	....	72.31	1.027
3	July 9	July 8	2	3.10	.89	3.00	6.98	....	....	71.62	1.024
4	July 13	July 11	2	2.74	1.20	2.05	5.99	....	....	65.05	1.025
5	July 13	July 12	2	2.48	1.79	4.53	8.80	....	....	65.34	1.025
6	July 14	July 14	1	3.21	2.85	2.66	8.72	....	....	72.78	1.032
7	July 18	July 18	1	3.03	5.21	1.35	9.59	....	.83	72.07	1.042
8	July 19	July 25	1	3.01	5.63	5.04	13.68	....	....	72.61	1.041
9	July 24	July 27	2	3.05	7.81	3.67	14.53	8.09	1.09	65.57	1.052
10	July 29	July 30	1	2.38	11.34	2.25	15.97	10.99	6.71	69.40	1.063
11	Aug. 1	Aug. 3	1	1.49	14.39	3.36	19.24	13.96	9.54	64.02	1.073
12	Aug. 8	Aug. 9	1	1.34	14.64	4.74	20.72	14.03	8.56	65.79	1.076
13	Aug. 13	Aug. 12	1	.92	16.90	3.15	20.97	16.18	12.83	62.18	1.082
14	Aug. 19	Aug. 16	1	1.31	15.15	3.26	19.72	14.25	10.68	61.94	1.080
15	Aug. 25	Aug. 19	2	.96	17.52	2.80	21.28	16.98	13.76	58.24	1.087
16	Aug. 30	Aug. 26	2	1.00	17.65	3.25	21.90	....	13.40	60.57	1.086

WHITE LIBERIAN—Continued.

MR. NESBIT—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	
17	Sept. 3	Sept. 3	2	.98	17.52	1.77	20.27	15.98	14.77	60.82	1.085
18	Sept. 13	Sept. 10	2	1.12	16.33	3.05	20.50	....	12.16	56.71	1.082
After 18....	Oct. 10	....	2	1.08	16.45	3.92	21.45	....	11.45	50.17	1.087
After 18....	Oct. 20	....	1	1.81	12.38	3.52	17.71	....	7.05	61.68	1.070
After 18....	Oct. 30	....	4	1.03	15.95	3.53	20.51	15.68	11.39	57.05	1.082
After 18....	Nov. 10	....	3	1.55	12.28	4.54	18.37	15.37?	6.19	54.16	1.074
After 18....	Nov. 17	....	2	1.32	12.52	4.02	17.86	....	7.18	53.51	1.071

WHITE LIBERIAN.

RUSH G. LEAMING.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 16	July 2	1	4.46	.46	1.40	6.32	....	....	72.92	1.027
2	July 8	July 5	2	3.30	.70	1.99	6.09	....	....	69.48	1.027
3	July 11	July 8	1	2.80	1.55	3.25	7.60	....	....	70.41	1.025
4	July 11	July 11	1	3.18	1.25	9.82	14.25	....	....	74.14	1.021
5	July 11	July 12	1	3.25	1.98	4.15	9.38	....	....	72.39	1.028
6	July 14	July 14	1	3.15	4.09	.99	8.23	....	....	69.23	1.038
7	July 18	July 18	1	2.84	6.94	1.25	11.03	....	2.85	60.33	1.047
8	July 19	July 25	1	2.98	7.15	3.38	13.51	....	.79	71.83	1.036
9	July 23	July 27	1	2.78	9.05	4.96	16.79	....	1.31	68.21	1.054
10	July 27	July 30	1	2.48	11.02	1.56	15.06	10.67	6.98	65.79	1.062
11	Aug. 1	Aug. 3	1	1.63	14.60	1.85	18.08	13.53	11.12	63.75	1.073
12	Aug. 8	Aug. 9	1	1.57	14.86	3.99	20.42	14.22	9.29	63.22	1.075
13	Aug. 13	Aug. 12	1	1.34	16.35	1.43	19.12	....	13.58	62.58	1.072
14	Aug. 19	Aug. 16	1	1.30	16.59	2.21	20.10	15.72	13.08	65.43	1.082
15	Aug. 25	Aug. 19	2	1.04	17.51	2.20	20.75	16.97	14.27	62.03	1.085
16	Aug. 30	Aug. 26	2	1.23	16.76	2.48	20.47	14.56	13.05	56.37	1.084
17	Sept. 5	Sept. 3	2	.93	18.80	2.75	22.47	....	15.12	57.22	1.093
18	Sept. 13	Sept. 10	2	1.26	16.28	3.40	20.94	....	11.62	53.13	1.085
After 18....	Oct. 10	....	2	1.19	14.04	3.62	18.85	....	9.23	55.45	1.075
After 18....	Oct. 20	....	1	1.09	15.12	4.25	20.46	....	9.78	59.61	1.080
After 18....	Oct. 30	....	4	1.60	12.60	3.97	18.17	7.83?	7.03	56.22	1.072
After 18....	Nov. 10	....	3	1.32	13.28	4.34	19.94	14.47	7.62	53.87	1.074
After 18....	Nov. 17	....	2	1.83	12.47	3.93	18.23	12.62	6.71	57.66	1.075

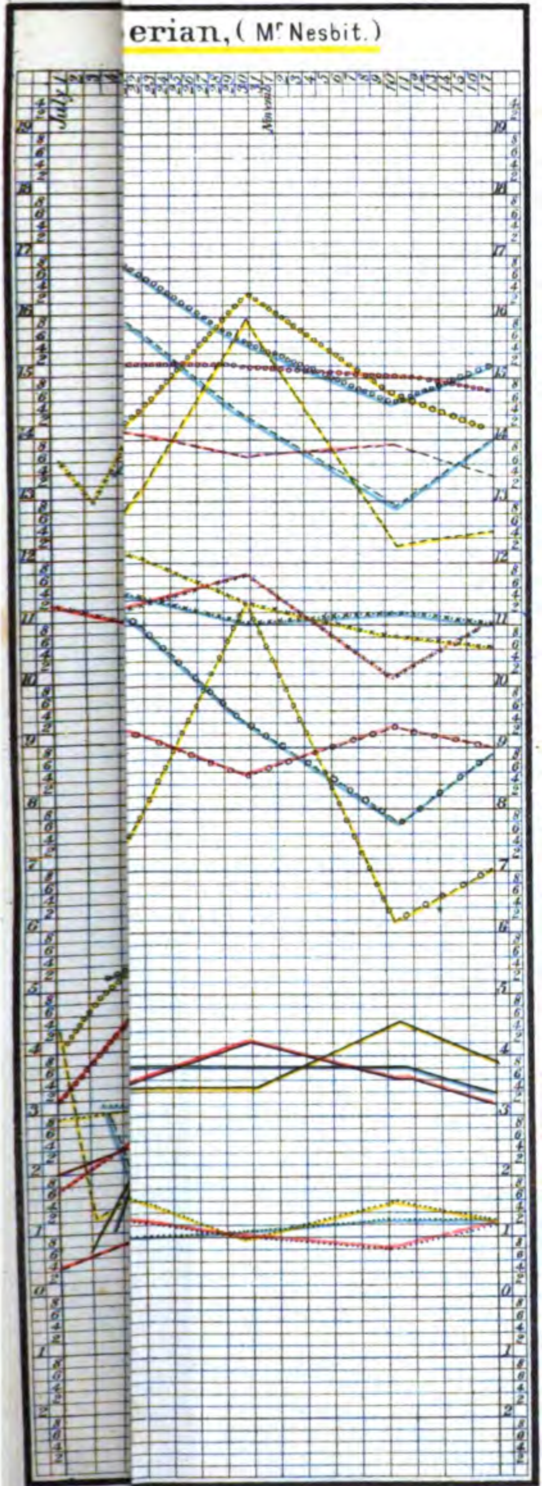
BLACK TOP.

D. W. AIKEN.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 16	July 3	1	2.06	2.72	3.61	8.39	....	....	67.35	1.030
2	July 6	July 6	1	2.00	1.13	2.65	5.78	....	....	66.60	1.020
3	July 10	July 9	2	2.42	2.19	4.05	9.12	....	....	70.50	1.026
4	July 12	July 12	1	3.52	1.47	4.10	9.19	....	....	70.49	1.028
5	July 14	July 15	1	3.30	2.34	3.23	8.96	....	....	71.89	1.032
6	July 14	July 16	1	3.81	2.45	8.45	14.71	....	....	71.48	1.033
7	July 18	July 17	1	4.53	3.41	.50	8.44	....	−1.62	70.23	1.042
8	July 19	July 18	1	2.45	6.41	3.20	12.06	....	.76	65.45	1.044
9	July 25	July 20	3	3.35	8.70	2.17	14.22	8.97	3.18	68.26	1.055
10	July 23	July 25	1	2.63	6.25	3.86	12.74	....	....	78.48?	1.044
11	Aug. 8	July 30	1	1.15	9.21	3.46	13.82	8.12	4.60	68.54	1.049
12	Aug. 13	Aug. 4	1	3.41	10.07	2.30	15.78	9.44	4.36	63.77	1.061
13	Aug. 19	Aug. 15	1	.78	15.17	2.94	18.84	....	11.50	68.00	1.077
14	Aug. 25	Aug. 17	2	1.18	15.40	3.05	19.63	15.70	11.17	62.23	1.082
15	Aug. 29	Aug. 19	1	.46	17.08	4.44	21.98	....	12.18	58.56	1.087
16	Aug. 31	Aug. 26	1	.96	19.20	3.09	23.25	....	15.15	58.94	1.091
17	Sept. 5	Sept. 3	2	1.33	15.56	2.32	19.21	....	11.91	61.68	1.069
18	Sept. 15	Sept. 10	2	1.49	14.11	2.98	18.58	....	9.64	57.22	1.077
After 18....	Oct. 10	....	2	.55	13.61	3.71	17.87	11.75	9.35	54.37	1.073
After 18....	Oct. 20	....	1	2.38	12.11	4.22?	18.71	....	5.51?	66.03	1.074
After 18....	Oct. 30	....	4	.90	12.50	3.90	17.30	11.91	7.70	56.76	1.077
After 18....	Nov. 10	....	3	.42	11.22	4.19	15.83	12.50	6.61	51.34	1.068
After 18....	Nov. 17	....	2	1.29	8.41	3.99	13.69	....	3.13	55.69	1.058

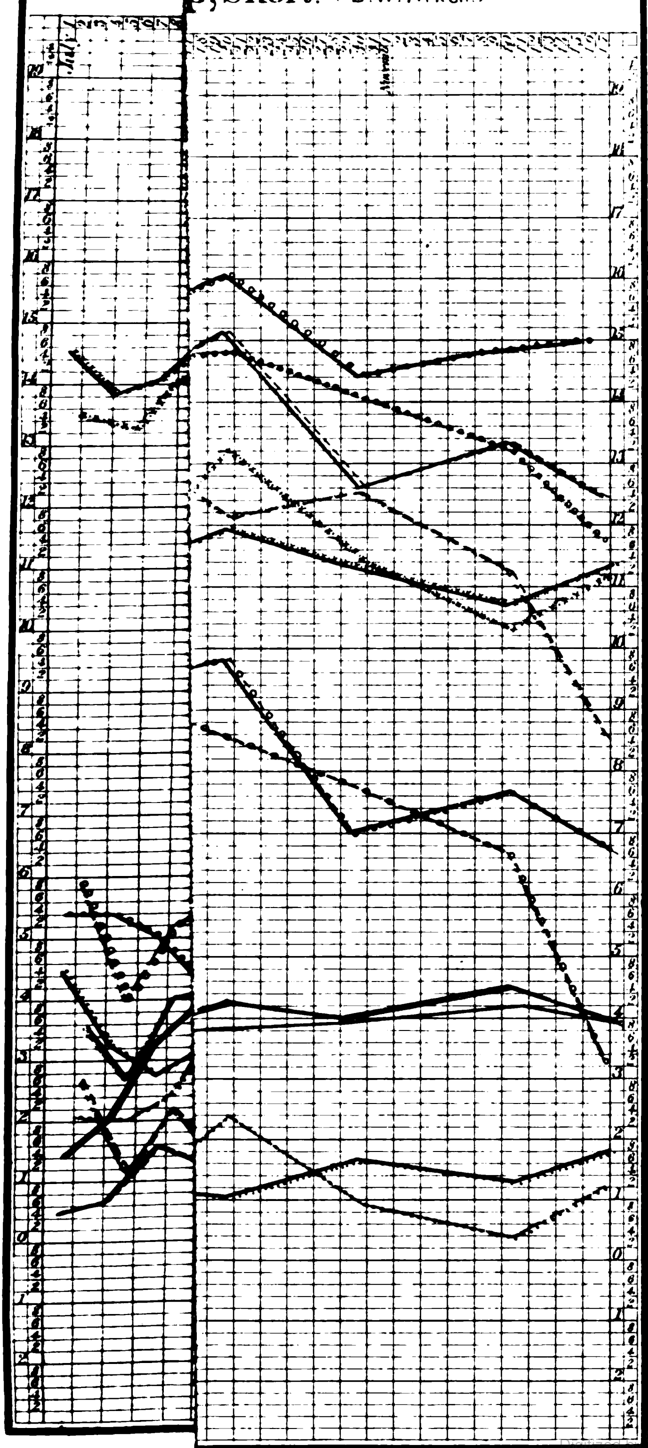
Plate I.

erian, (Mr Nesbit.)



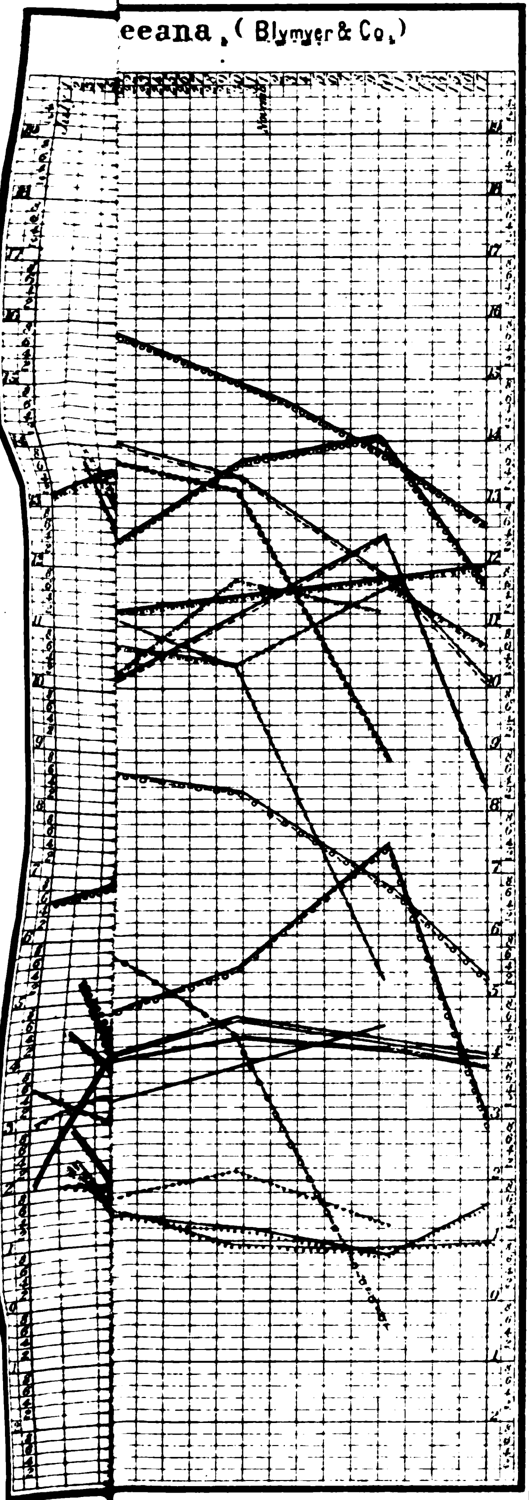
— o – Available Sugar.

p, Short. (D.W. Aiken.)



o – o – o – Available Sugar.

Plate III.



o – o – Available Sugar.

Plate IV.

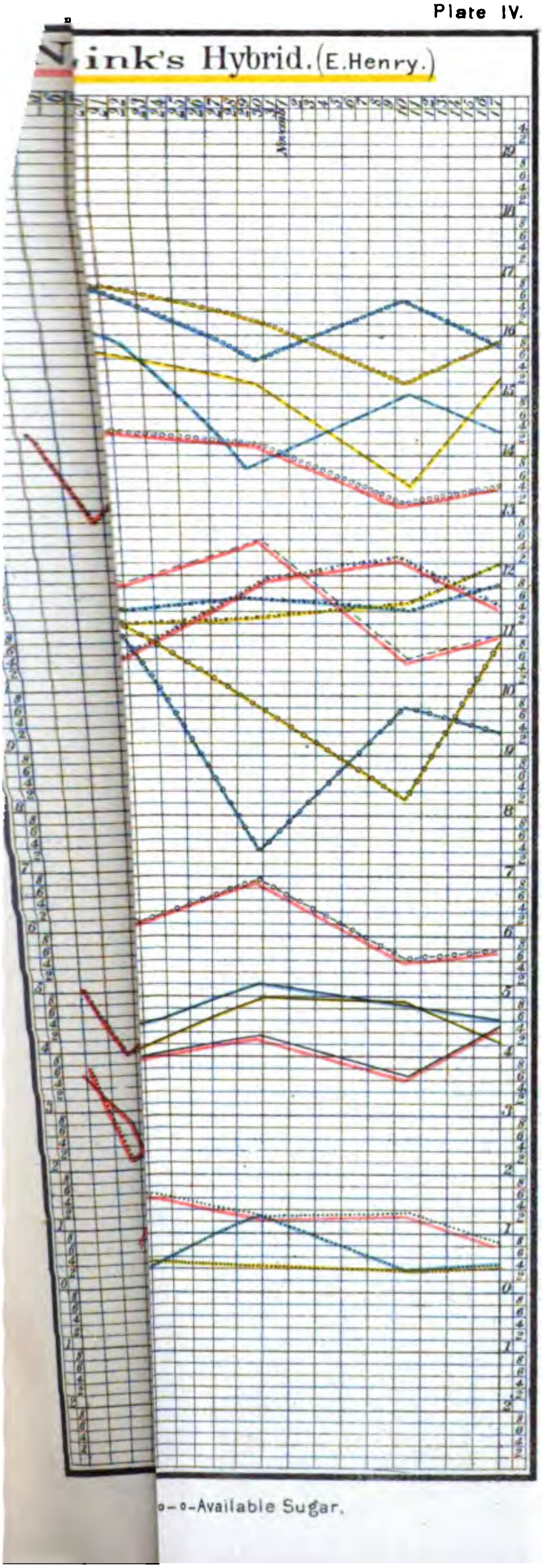
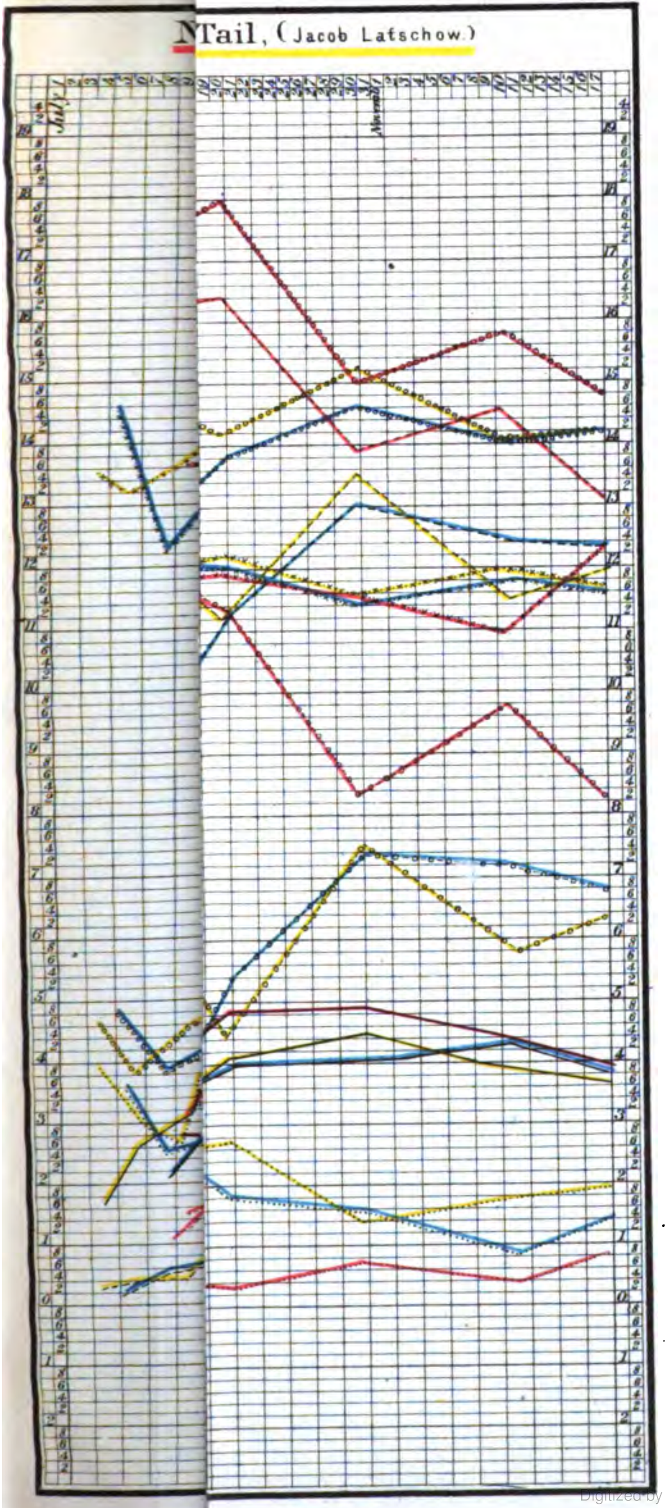


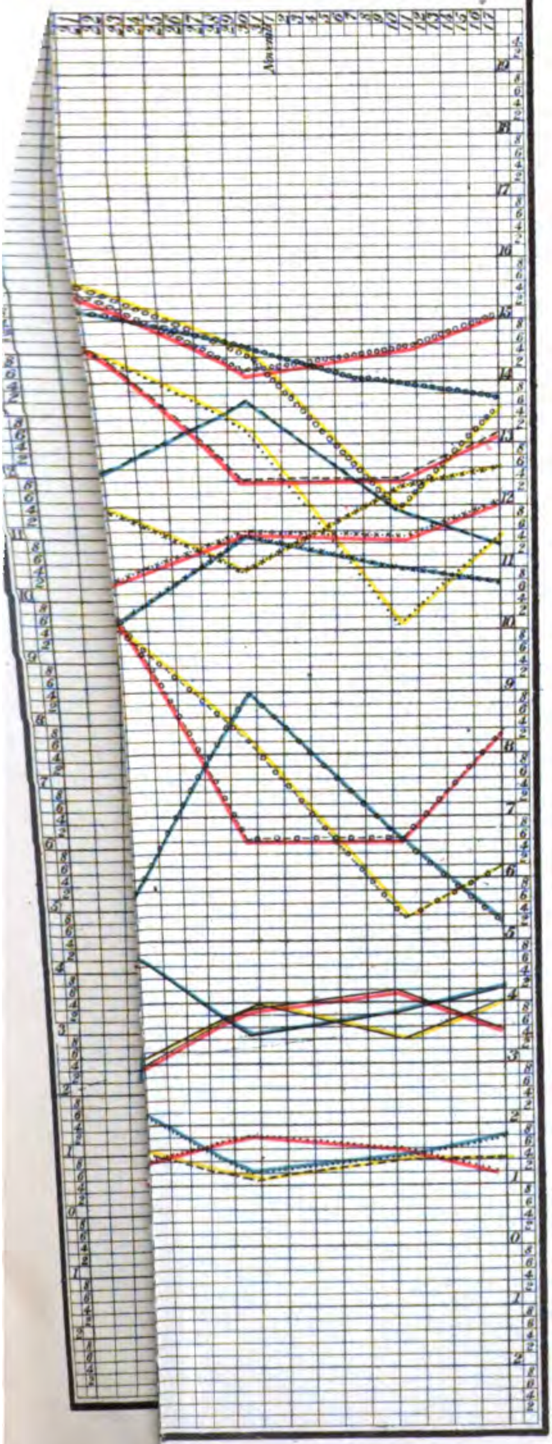
Plate V.



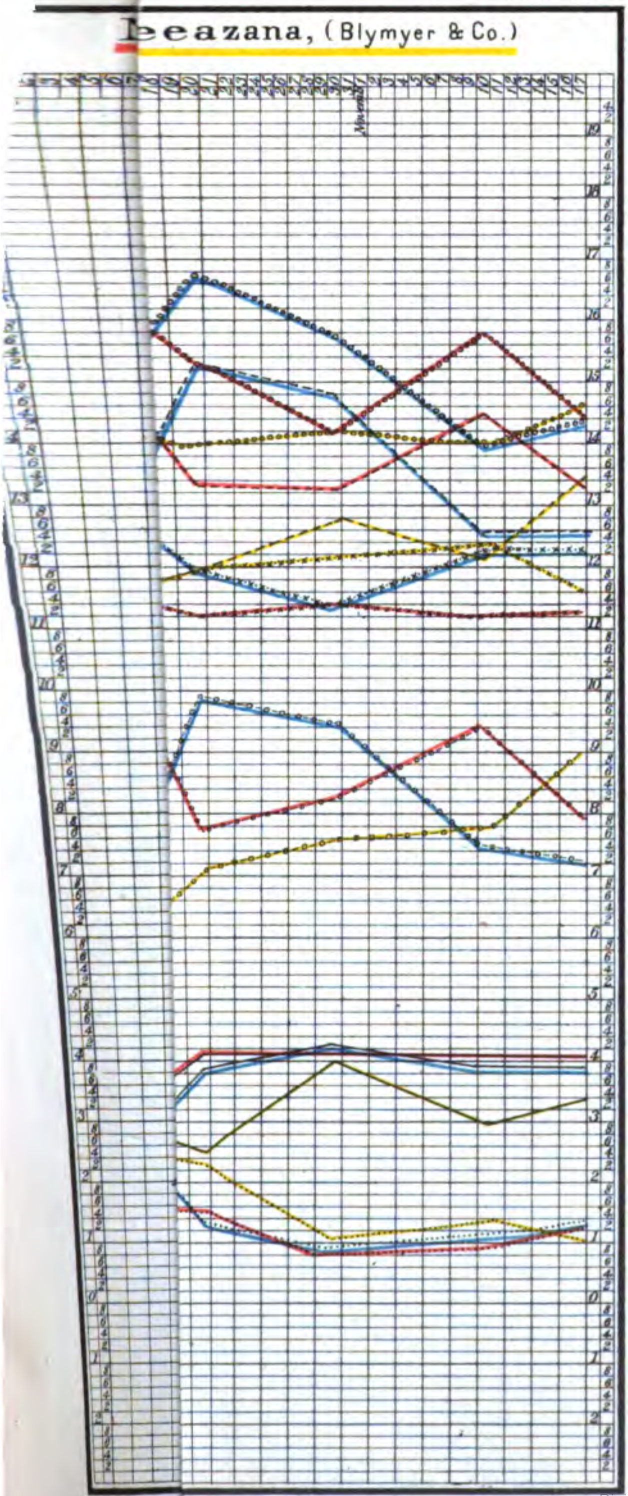
o – o – o – Available Sugar.

Plate VI.

ly Orange, (Hedges.)



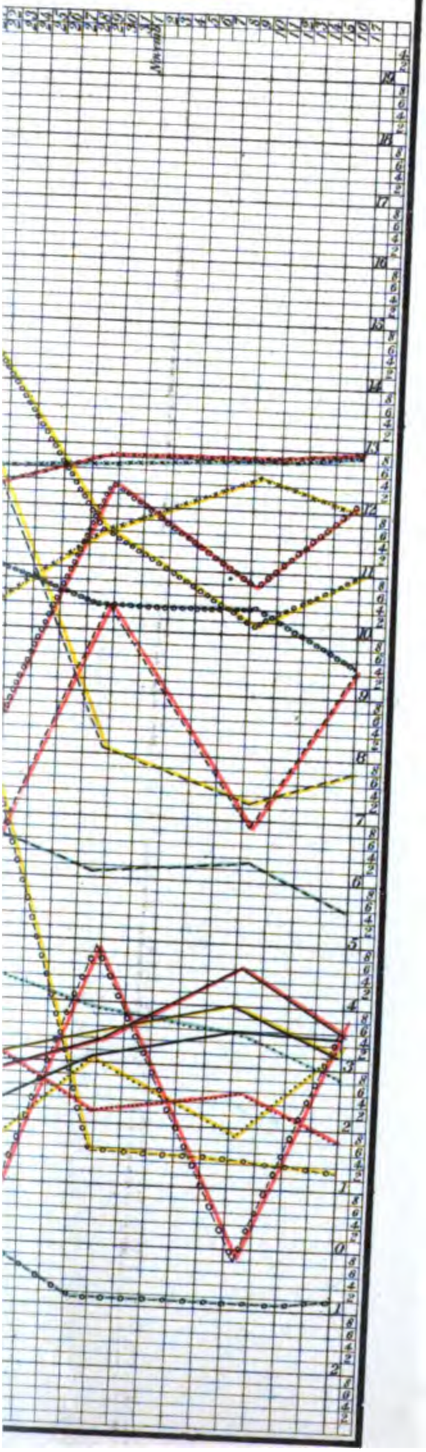
o-o-Available Sugar.



-o-o-o-Available Sugar.

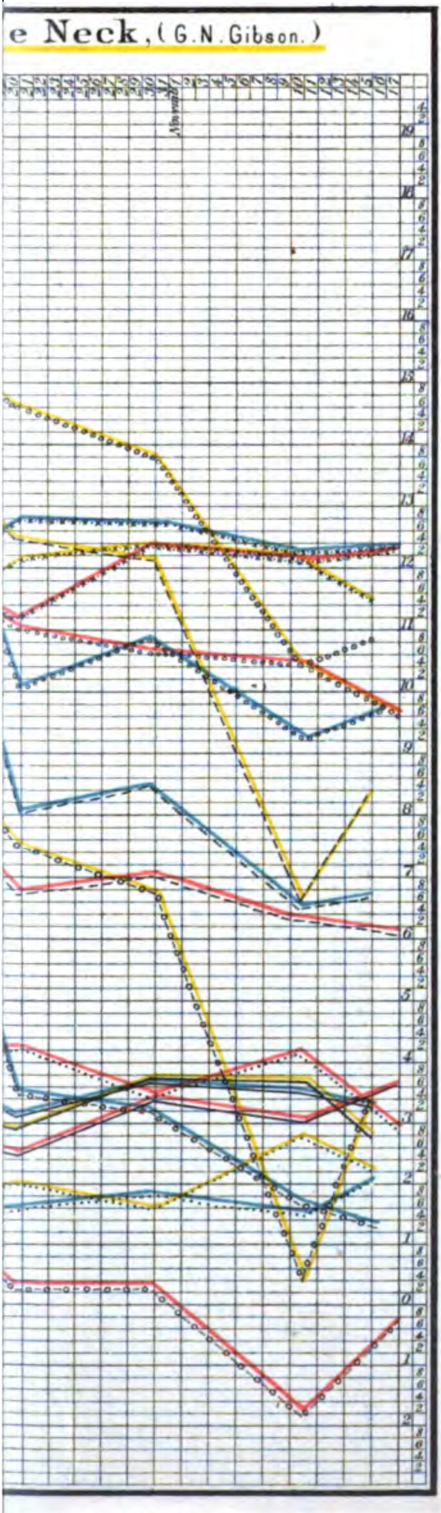
Plate IX.

...ane, (C.E. Miller.)



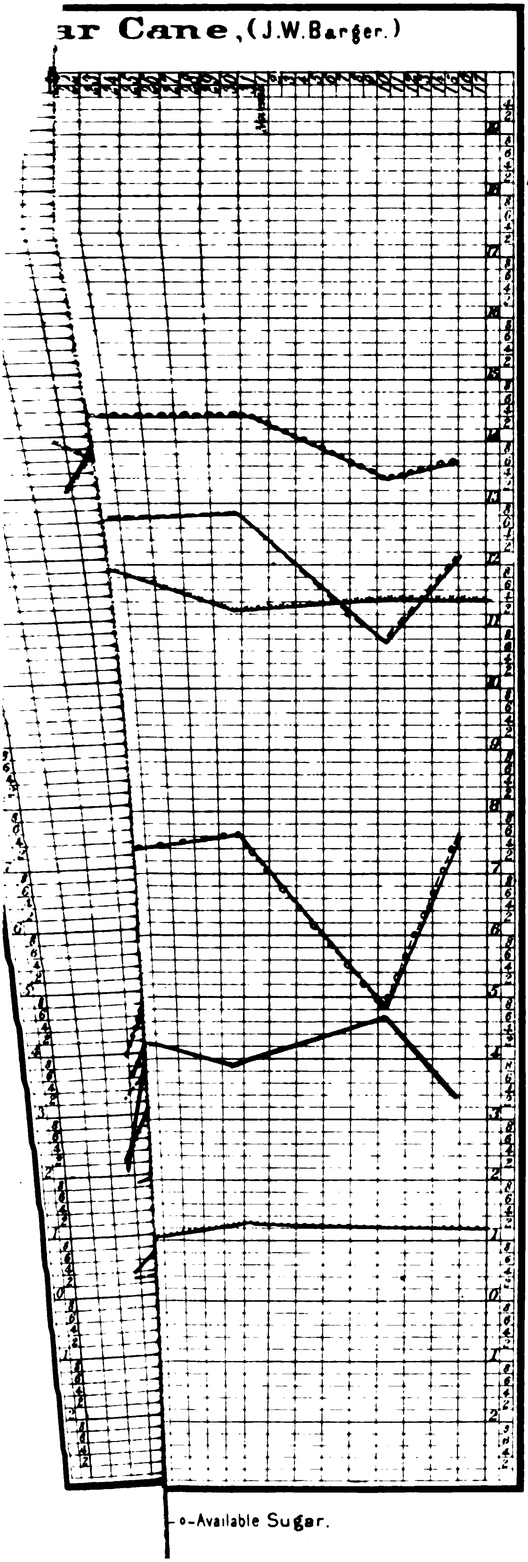
-Available Sugar.

Plate X.

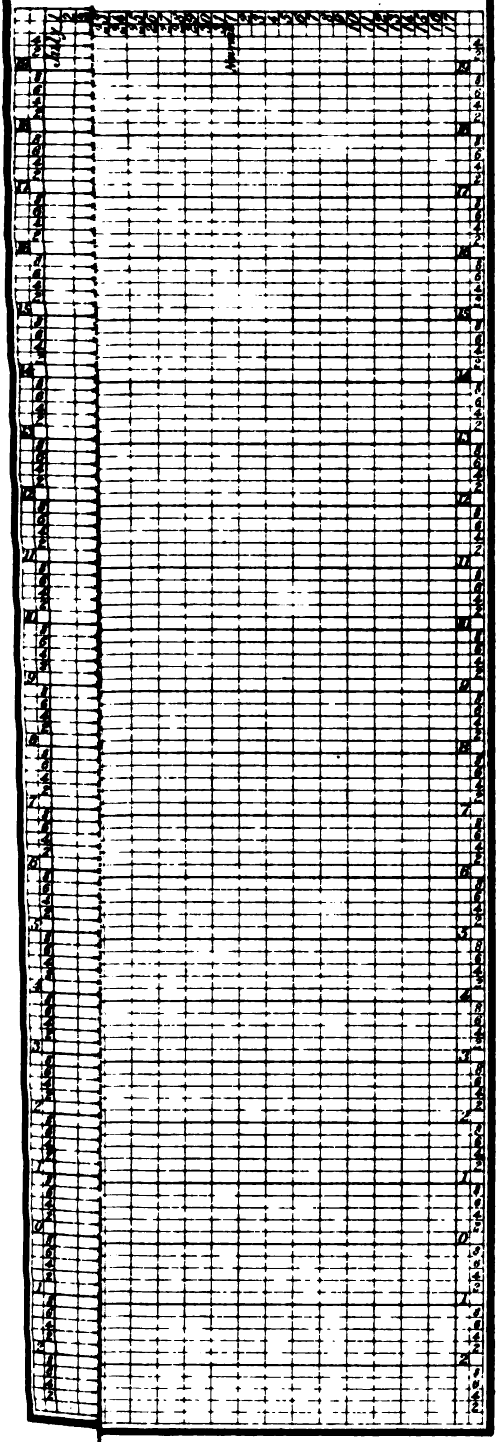


—o—o—Available Sugar.

Plate XI.

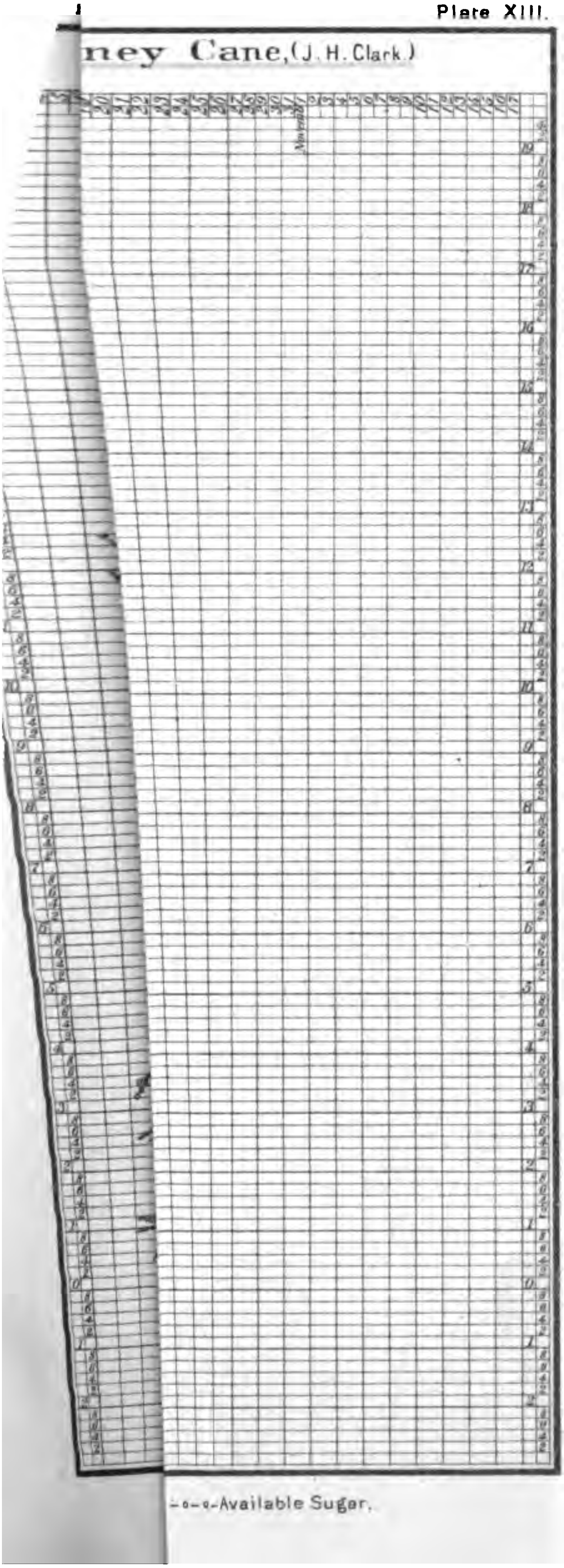


accharatus. (Vilmorin)



o–Available Sugar.

Plate XIII.



BLACK TOP, TALL.

D. W. Aiken.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
1	July 26	July 24	1	1.81	4.69	2.47	8.97	....	.41	61.06	1.036
2	July 26	July 26	1	1.56	4.95	1.85	8.36	....	1.54	59.16	1.036
3	July 27	July 27	1	1.87	5.66	1.19	8.72	....	2.60	58.89	1.039
4	Aug. 1	July 30	3	1.55	6.24	3.60	11.39	5.31	1.09	58.53	1.044
5	July 30	Aug. 1	2	2.29	5.79	4.28	12.36	4.36	—.78	60.00	1.043
6	Aug. 5	Aug. 12	1	1.19	7.93	4.50	13.62	7.75	2.24	58.08	1.050
7	Aug. 11	Aug. 19	2	1.69	9.79	4.37	15.85	8.98	3.73	57.41	1.060
8	Aug. 19	Aug. 22	2	1.35	11.50	2.24	15.09	10.30	7.91	56.69	1.064
9	Aug. 25	Aug. 26	3	1.17	14.42	2.45	18.04	13.28	10.80	53.87	1.077
10	Aug. 29	Aug. 29	1	.68	15.75	5.18	21.61	....	9.89	55.15	1.087
11	Sept. 3	Sept. 3	1	.78	11.97	7.34?	20.09?	....	3.85?	56.41	1.065
13	Sept. 12	Sept. 12	1	.87	12.27	3.77	16.91	....	7.63	45.16	1.070
14	Sept. 17	Sept. 17	1	.69	13.28	3.73	17.70	....	8.86	53.97	1.073

AFRICAN.

W. E. Parks.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 16	July 8	1	1.99	2.45	2.91	7.35	....	....	68.09	1.027
2	July 6	July 6	1	1.84	1.28	1.64	4.76	....	....	61.42	1.018
3	July 10	July 9	2	1.91	2.31	4.23	8.46	....	....	67.87	1.024
4	July 12	July 15	1	3.10	1.20	3.38	7.68	....	....	65.09	1.028
5	July 14	July 16	1	1.79	3.25	2.77	7.81	....	—1.31	69.07	1.030
6	July 18	July 18	1	1.99	4.41	1.04	7.44	....	1.38	68.69	1.035
7	July 19	July 19	1	2.52	6.96	4.86	14.34	....	—.42	69.11	1.046
8	July 23	July 20	1	2.93	5.82	4.62	13.37	....	—1.73	66.71	1.047
9	July 23	July 25	1	2.78	4.76	4.40	11.94	....	—2.42	66.88	1.042
10	July 25	July 30	1	2.32	7.84	2.30	12.46	7.58	3.22	65.20	1.051
11	Aug. 5	Aug. 3	1	3.03	6.52	4.31	13.86	7.01	—.82	68.83	1.050
12	Aug. 9	Aug. 12	1	2.92	6.76	1.98	11.66	6.25	1.86	65.18	1.046
13	Aug. 13	Aug. 16	1	1.87	11.78	2.73	16.38	11.19	7.18	63.58	1.068
14	Aug. 19	Aug. 19	1	2.96	8.31	1.60	12.77	....	3.75	68.12	1.057
15	Aug. 25	Aug. 24	2	1.28	16.62	2.17	20.07	....	13.17	62.10	1.076
16	Aug. 30	Aug. 29	3	2.42	13.66	2.49	18.57	15.05	8.75	62.22	1.075
17	Sept. 8	Sept. 3	3	1.38	17.47	2.83	21.68	14.55	13.26	52.71	1.089
18	Sept. 17	Sept. 17	1	.57	17.69	3.12	21.38	....	14.00	59.30	1.087
After 18....	Oct. 10	....	2	2.13	14.66	3.60	20.39	....	8.93	55.06	1.083
After 18....	Oct. 30	....	4	.86	13.45	4.29	18.60	13.27	8.30	57.12	1.075
After 18....	Nov. 10	....	3	.82	11.71	4.12	16.65	9.59	6.77	57.78	1.069
After 18....	Nov. 17	....	2	.96	10.01	3.89	14.86	10.65	5.16	53.25	1.062

AFRICAN SHORT.

W. E. Parks.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
15	Aug. 24	Aug. 24	3	1.14	12.57	4.12	17.83	....	7.31	68.61	1.077
16	Sept. 3	Sept. 3	1	3.49	11.94?	6.91	22.34	15.27?	1.54	60.00	1.074
17	Sept. 12	Sept. 12	1	2.70	12.30	3.12	18.12	....	6.48	51.86	1.076
18	Sept. 17	Sept. 17	1	1.28	12.12	4.12	17.52	....	6.72	61.05	1.073

WHITE MAMMOTH.

Amos Carpenter.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
Before 1	July 8	June 23	1	1.11	.26	3.17	4.54	....	....	65.67	1.012
1	July 12	June 25	1	1.81	.49	1.67	3.97	....	....	67.58	1.020
2	July 27	June 30	2	3.02	3.73	1.86	8.61	3.27	....	65.62	1.033
3	July 30	July 5	2	3.45	3.02	3.92	10.39	2.90	—4.35	67.65	1.034
4	Aug. 5	July 10	1	2.71	6.74	3.69	13.14	6.96	.34	65.05	1.046
5	Aug. 9	July 25	1	3.28	7.71	1.87	12.86	7.15	2.56	69.17	1.050
6	Aug. 9	Aug. 3	1	3.52	6.13	2.06	11.71	6.02	.55	69.35	1.046
7	Aug. 13	Aug. 13	1	2.17	9.55	2.74	14.46	8.93	4.64	66.47	1.054
8	Aug. 19	Aug. 19	1	2.41	12.07	1.32	15.80	10.96	8.34	70.35	1.066

WHITE MAMMOTH—Continued.

AMOS CARPENTER—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	[illegible]
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
9	Aug. 25	Aug. 24	2	2.39	10.09	3.81	16.29	11.79	3.89	66.02	[illegible]
10	Aug. 29	Aug. 29	2	1.99	14.08	2.91	18.98	13.60	9.18	62.96	[illegible]
11	Aug. 31	Aug. 30	2	1.88	15.73	2.41	20.02	5.07?	11.44	65.65	[illegible]
12	Sept. 3	Sept. 3	2	1.49	16.10	6.75?	24.34	....	7.86?	35.89	[illegible]
13	Sept. 7	Sept. 4	2	1.76	15.82	2.65	20.23	15.23	11.41	62.01	[illegible]
14	Sept. 12	Sept. 12	1	1.62	15.65	1.52	18.79	....	12.51	63.64	[illegible]
15	Sept. 19	Sept. 19	1	.83	16.29	7.27?	24.38	....	8.10?	58.01	[illegible]
After 18....	Oct. 10	....	2	1.23	13.38	3.69	18.30	14.13	8.46	59.01	[illegible]
After 18....	Oct. 20	....	1	1.31	9.98	3,97	15.26	9.54	4.70	56.17	[illegible]
After 18....	Oct. 30	....	4	1.07	11.11	4.61	16.79	12.18	5.43	57.36	[illegible]
After 18....	Nov. 10	....	3	.66	12.35	4.26	17.27	13.36	7.43	58.80	[illegible]
After 18....	Nov. 17	....	2	1.62	8.25	3.91	13.78	8.05	2.72	60.15	[illegible]

OOMSEEANA.

BLYMYER & CO.

1	July 18	July 8	1	2.01	2.32	4.58	8.91	....	....	70.43	[illegible]
2	July 6	July 6	1	1.90	1.55	1.79	5.24	....	....	64.71	[illegible]
3	July 11	July 9	2	2.32	.83	3.00	6.75	....	....	61.60	[illegible]
4	July 13	July 11	1	3.43	1.36	2.91	7.70	....	....	65.94	[illegible]
5	July 15	July 12	1	1.88	2.86	5.72	10.48	....	....	68.15	[illegible]
6	July 15	July 15	1	3.47	1.23	2.60	7.30	....	....	67.57	[illegible]
7	July 19	July 18	1	4.11	2.18	1.83	8.12	....	—3.76	70.82	[illegible]
8	July 20	July 20	1	1.46	9.38	3.44	14.28	....	4.48	69.60	[illegible]
9	July 20	July 25	1	2.38	7.27	3.27	12.92	....	1.63	70.39	[illegible]
10	July 25	July 30	2	1.55	8.50	3.19	13.24	6.73	2.76	65.53	[illegible]
11	Aug. 1	Aug. 3	1	1.95	5.67	2.38	10.00	5.10	1.34	68.71	[illegible]
12	Aug. 9	Aug. 12	1	3.57	5.49	1.88	10.94	5.30	.04	66.18	[illegible]
13	Aug. 15	Aug. 16	1	.87	13.17	2.79	16.83	12.84	9.51	61.60	[illegible]
14	Aug. 19	Aug. 19	1	.81	15.33	2.66	18.80	....	11.86	60.46	1.077
15	Aug. 25	Aug. 24	2	1.96	14.98	1.51	18.45	13.88	11.51	62.91	1.075
16	Aug. 30	Aug. 29	2	2.15	15.62	2.69	20.46	12.42	10.78	63.72	[illegible]
17	Sept. 5	Sept. 3	2	1.34	17.00	2.20	20.54	15.95	13.46	60.84	[illegible]
18	Sept. 15	Sept. 12	2	1.49	14.53	1.79	17.81	12.30	11.25	59.35	[illegible]
After 18....	Oct. 10	....	1	.95	17.22?	2.94	21.11	....	13.33	48.46	[illegible]
After 18....	Oct. 20	....	2	1.69	3.53	3.28	8.50	....	....	50.17	[illegible]
After 18....	Oct. 30	....	4	2.14	10.45	3.94	16.53	9.74	4.37	56.80	[illegible]
After 18....	Nov. 10	....	2	1.28	5.21	4.46	10.95	....	—.53	56.10	1.044

REGULAR SORGHO.

BLYMYER & CO.

1	July 18	July 8	1	3.71	....	3.60	7.31	....	....	71.56	[illegible]
2	July 6	July 6	1	2.07	.53	2.78	5.38	....	....	64.03	[illegible]
3	July 11	July 9	2	2.53	1.64	1.26	5.43	....	....	68.95	[illegible]
4	July 13	July 13	1	1.86	2.43	2.78	7.07	....	....	71.57	[illegible]
5	July 15	July 15	1	2.92	1.20	1.74	6.86	....	....	69.41	[illegible]
6	July 15	July 16	1	3.53	2.15	2.69	8.37	....	—4.07	67.77	[illegible]
7	July 19	July 18	1	1.55	5.74	3.22	10.51	....	.97	56.34	[illegible]
8	July 20	July 20	1	2.96	3.42	3.35	9.73	....	—2.89	71.19	[illegible]
9	July 20	July 25	1	3.14	5.47	2.96	11.57	....	—.63	70.34	[illegible]
10	July 27	July 30	3	2.81	7.82	3.40	14.03	7.84	2.67	61.03	[illegible]
11	Aug. 2	Aug. 3	1	1.86	8.60	2.87	13.83	....	3.87	65.52	[illegible]
12	Aug. 9	Aug. 12	1	1.98	8.29	2.76	13.03	7.51	3.55	59.38	[illegible]
13	Aug. 15	Aug. 16	1	1.40	11.56	3.42	16.38	....	6.74	42.14	[illegible]
14	Aug. 19	Aug. 19	1	2.12	10.85	1.58	14.55	....	7.15	62.53	[illegible]
15	Aug. 25	Aug. 25	1	2.24	14.67	2.97	19.88	14.33	9.46	58.35	[illegible]
16	Aug. 30	Aug. 29	2	1.12	14.54	4.52	20.18	....	8.90	53.66	[illegible]
17	Sept. 5	Sept. 3	2	1.52	16.04	2.76	20.32	16.24	11.76	60.12	[illegible]
18	Sept. 15	Sept. 12	2	2.11	13.20	2.07	17.38	9.05	9.02	59.60	[illegible]
After 18....	Oct. 10	....	1	2.12	12.54	2.58	17.24	....	7.84	61.19	[illegible]
After 18....	Oct. 20	....	2	1.69	11.90	3.98	17.57	10.00	6.23	53.58	[illegible]
After 18....	Oct. 30	....	4	1.29	12.51	4.36	18.16	10.77	6.86	59.50	[illegible]
After 18....	Nov. 10	....	3	1.35	10.63	3.67	15.65	10.36	5.61	61.28	[illegible]
After 18....	Nov. 17	....	2	.83	11.07	4.53	16.42	....	5.72	57.50	[illegible]

LINK'S HYBRID.

E. LINK.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
Before 1	July 8	July 8	1	1.63	.79	2.30	4.72	....	....	67.20	1.015
1	July 18	July 16	1	2.16	2.43	2.72	7.31	....	....	67.18	1.025
2	July 19	July 20	1	2.21	3.42	1.53	7.16	....	....	67.48	1.033
3	July 20	July 23	1	1.88	3.96	2.40	8.21	....	....	65.11	1.031
4	July 26	July 25	3	2.33	5.52	4.62	11.87	7.23	....	68.75	1.044
5	July 27	July 26	4	2.73	4.65	2.21	9.59	4.26	— .29	69.72	1.037
6	Aug. 1	July 27	2	2.74	6.78	3.12	12.64	2.93	.92	68.58	1.045
7	Aug. 7	July 29	2	2.01	10.82	3.23	16.06	10.36	5.58	64.24	1.060
8	Aug. 11	July 30	1	3.01	9.04	2.69	14.74	8.82	3.34	69.30	1.058
9	Aug. 15	Aug. 3	1	1.07	14.74	2.55	18.36	14.52	11.12	65.40	1.078
10	Aug. 19	Aug. 12	1	1.55	13.42	2.60	17.57	....	9.27	64.88	1.071
11	Aug. 25	Aug. 16	2	1.74	15.85	2.67	20.26	15.53	11.44	59.63	1.082
12	Aug. 29	Aug. 19	1	1.50	14.80	3.28	19.58	....	10.02	65.86	1.080
13	Aug. 31	Aug. 25	1	1.10	16.85	2.82	20.77	....	12.93	54.30	1.078
14	Sept. 3	Aug. 31	1	1.79	14.94	7.16?	23.89?	....	5.99?	64.09	1.082
15	Sept. 8	Sept. 5	1	.83	17.86	3.39	22.08	....	13.64	57.69	1.089
16	Sept. 12	Sept. 12	1	.80	18.18	2.85	21.83	....	14.53	58.33	1.090
17	Sept. 19	Sept. 19	1	.34	17.92	7.65?	25.91?	....	9.98?	52.74	1.092
After 18	Oct. 10	....	1	.51	17.38	4.12	22.01	....	12.75	58.02	1.090
After 18	Oct. 20	....	2	.45	16.04	4.57	21.06	....	11.02	57.47	1.084
After 18	Oct. 30	....	4	1.28	13.81	5.14	20.23	14.26	7.39	58.24	1.078
After 18	Nov. 10	....	3	.34	14.93	4.79	20.06	15.15	9.80	57.31	1.083
After 18	Nov. 17	....	2	.45	14.40	4.54	19.39	14.21	9.41	58.38	1.079

LINK'S HYBRID.

EDWIN HENRY.

Before 1	July 8	July 8	1	1.47	.98	3.10	5.50	....	....	70.69	1.017
1	July 18	July 16	1	2.19	2.22	2.51	6.92	....	....	72.45	1.025
2	July 19	July 20	1	2.13	3.04	1.18	6.35	....	....	66.00	1.030
3	July 20	July 25	1	2.39	4.34	3.14	9.87	....	— 1.19	68.52	1.033
4	July 27	July 27	1	2.72	7.46	1.86	12.04	7.17	2.84	65.19	1.047
5	July 28	July 29	2	2.66	7.47	1.62	11.75	6.59	3.18	67.64	1.048
6	Aug. 1	July 30	2	2.81	9.28	2.80	15.39	7.96	4.17	63.49	1.057
7	Aug. 5	Aug. 2	1	2.61	8.01	3.87	14.49	7.69	1.53	63.72	1.052
8	Aug. 10	Aug. 4	1	2.70	11.25	1.55	15.50	10.65	7.00	67.50	1.064
9	Aug. 15	Aug. 6	1	1.98	12.22	2.54	16.74	12.12	7.70	63.39	1.069
10	Aug. 19	Aug. 12	2	2.05	12.68	2.60	17.28	12.19	7.98	64.07	1.071
11	Aug. 25	Aug. 17	2	1.69	15.80	2.59	20.08	15.23	11.52	64.04	1.082
12	Aug. 29	Aug. 19	1	1.38	15.58	3.51	20.47	....	10.69	65.11	1.082
13	Sept. 1	Aug. 25	1	1.58	16.41	2.43	20.42	....	12.40	63.20	1.082
14	Sept. 5	Sept. 1	2	1.38	17.63	3.48	22.49	17.10	12.77	62.81	1.088
15	Sept. 8	Sept. 8	1	.66	18.86	3.33	22.85	....	14.87	54.59	1.094
16	Sept. 12	Sept. 12	1	1.03	17.03	2.56	20.62	....	13.44	59.56	1.086
17	Sept. 19	Sept. 19	1	.34	18.28	7.09?	25.71?	....	10.85?	55.21	1.091
After 18	Oct. 10	....	1	.42	16.89	3.38	20.69	....	13.00	57.25	1.085
After 18	Oct. 20	....	2	.50	15.78	4.09	20.32	14.75	11.14	55.73	1.084
After 18	Oct. 30	....	4	.45	15.20	4.92	20.57	14.45	9.83	56.42	1.081
After 18	Nov. 10	....	3	.36	13.54	4.89	18.79	....	8.29	57.62	1.076
After 18	Nov. 17	....	2	.40	15.41	4.15	19.96	15.39	10.86	60.71	1.080

SUGAR CANE.

EPHRAIM LINK.

Before 1	July 9	July 9	1	1.41	1.21	2.79	5.41	....	....	68.06	1.015
1	July 18	July 16	1	2.07	2.63	2.70	7.40	....	....	68.41	1.026
2	July 19	July 18	1	2.11	3.24	1.19	6.54	....	....	69.48	1.031
3	July 20	July 20	1	2.98	2.94	2.40	8.32	....	....	66.08	1.027
4	July 23	July 25	1	2.63	4.39	3.97	10.99	....	— 2.21	71.63	1.037
5	July 27	July 27	3	2.31	6.14	2.49	10.94	5.94	1.34	68.57	1.042
6	July 31	July 29	3	2.57	6.82	2.83	12.22	6.14	1.42	69.82	1.048
7	July 30	July 30	2	2.58	7.01	5.77	15.36	6.95	— 1.34	69.72	1.049
8	Aug. 5	Aug. 2	1	2.24	9.11	4.27	15.62	9.20	3.60	67.85	1.056
9	Aug. 10	Aug. 6	1	1.28	13.64	2.12	17.04	12.98	10.24	75.73	1.071

SUGAR CANE—Continued.

EPHRAIM LINK—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
10	Aug. 15	Aug. 13	1	1.10	15.14	2.48	18.72	14.82	11.56	61.81	1.079
11	Aug. 19	Aug. 15	1	1.74	14.88	1.98	18.60	....	11.16	62.57	[illegible]
12	Aug. 25	Aug. 17	1	1.36	15.60	3.01	19.97	....	11.23	60.13	[illegible]
13	Aug. 29	Aug. 19	2	1.56	15.18	3.01	19.75	14.20	10.61	66.48	1.076
14	Sept. 1	Aug. 25	1	1.27	16.57	2.49	20.33	....	12.81	63.41	[illegible]
15	Sept. 5	Aug. 29	1	1.09	16.84	3.21	21.14	16.36	12.54	61.61	[illegible]
16	Sept. 8	Sept. 1	1	.79	16.12	4.87	21.78	17.55	10.46	60.88	[illegible]
17	Sept. 14	Sept. 8	1	5.14?	19.51	.05	24.70?	....	14.32	55.67	1.093
18	Sept. 19	Sept. 13	1	.69	15.37	7.06?	23.12	....	7.62?	59.17	1.081
After 18	Oct. 10	....	1	.57	16.30	3.19	20.06	....	12.54	58.88	1.084
After 18	Oct. 20	....	2	.29	16.59	4.85	21.73	15.63	11.45	59.58	[illegible]
After 18	Oct. 30	....	4	.69	13.95	4.86	19.50	14.52	8.40	58.36	1.077
After 18	Nov. 10	....	3	.40	14.57	4.43	19.40	14.61	9.73	54.87	[illegible]
After 18	Nov. 17	....	2	.86	13.07	4.04	17.97	14.19	8.17	61.52	1.074

GOOSE NECK.

P. P. RAMSEY.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 16	July 5	1	3.62	.14	2.19	5.95	....	....	73.00	1.024
2	July 8	July 8	1	2.45	.46	2.21	5.15	....	....	60.79	1.019
3	July 12	July 13	1	2.79	.65	5.46	8.90	....	....	68.96	1.022
4	July 13	July 15	1	3.15	.55	3.88	7.58	....	....	71.66	1.022
5	July 15	July 16	1	3.25	.51	1.81	5.57	....	....	72.00	1.033
6	July 18	July 18	1	4.04	1.91	2.28	8.23	....	....	72.34	1.033
7	July 19	July 20	1	4.23	2.29	.82	7.34	....	....	66.45	1.034
8	July 22	July 25	2	4.33	4.21	2.78	11.32	....	....	69.97	1.041
9	July 26	July 27	2	3.61	5.76	3.03	12.40	7.77	— .88	68.87	1.046
10	Aug. 1	July 30	1	3.01	8.84	2.84	14.69	8.15	2.99	68.81	1.056
11	Aug. 10	Aug. 8	1	1.89	12.98	1.98	16.85	....	9.11	61.24	1.068
12	Aug. 15	Aug. 13	1	2.59	10.28	2.14	15.01	9.89	5.55	65.26	1.062
13	Aug. 19	Aug. 19	1	4.03	6.70	1.06	11.79	5.04	1.61	66.88	1.048
14	Aug. 25	Aug. 25	1	3.53	10.93	1.51	15.97	....	5.89	71.71	1.064
15	Aug. 29	Aug. 29	1	1.54	15.93	2.51	19.98	....	11.88	58.83	1.081
16	Sept. 1	Sept. 1	1	1.60	15.30	2.23	19.13	....	11.47	56.53	1.066
17	Sept. 7	Sept. 5	2	1.57	16.61	3.14	21.32	15.82	11.90	55.67	1.081
18	Sept. 16	Sept. 14	2	1.29	16.19	4.81	22.29	....	10.09	58.28	1.079
After 18	Oct. 10	....	1	3.57	7.82	2.96	14.35	....	1.29	61.01	1.059
After 18	Oct. 20	....	2	1.79	11.15	3.98	16.92	....	5.38	60.00	1.069
After 18	Oct. 30	....	4	1.58	13.03	4.08	18.69	12.75	7.37	56.80	1.073
After 18	Nov. 10	....	3	.89	12.41	4.29	17.59	10.95	7.23	58.88	1.070
After 18	Nov. 17	....	2	1.48	12.30	3.92	17.70	11.94	6.90	57.81	1.071

BEAR TAIL.

JACOB LATSHAW.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 18	July 4	1	3.94	.27	1.65	5.86	....	....	67.91	1.023
2	July 6	July 6	1	3.12	....	2.57	5.69	....	....	66.11	1.019
3	July 11	July 9	3	2.63	.42	3.01	6.06	....	....	68.37	[illegible]
4	July 13	July 10	1	3.72	.69	3.56	7.67	....	....	69.43	1.023
5	July 13	July 12	1	3.65	.87	5.22	9.74	....	....	70.11	[illegible]
6	July 15	July 14	1	3.89	.92	2.29	7.10	....	....	67.49	[illegible]
7	July 16	July 16	1	3.30	2.12	2.13	8.55	....	....	74.02	1.029
8	July 19	July 18	1	3.83	3.34	.73	7.90	....	....	68.74	[illegible]
9	July 23	July 20	3	3.87	5.28	3.01	12.16	6.10	....	68.25	1.046
10	July 28	July 30	3	3.04	5.61	4.46	13.11	6.81	....	68.20	[illegible]
11	Aug. 1	Aug. 8	1	3.04	3.77	7.15	14.86	7.86	....	67.93	[illegible]
12	Aug. 10	Aug. 12	1	2.62	12.05	2.15	16.82	11.79	7.28	64.02	[illegible]
13	Aug. 15	Aug. 16	1	2.56	12.09	2.35	17.00	13.20	8.08	65.51	[illegible]
14	Aug. 20	Aug. 19	1	2.16	12.88	3.29	18.33	....	7.43	58.49	[illegible]
15	Aug. 25	Aug. 25	1	2.44	15.93	1.90	20.27	....	11.59	59.52	1.083

BEAR TAIL—Continued.

Jacob Latshaw—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
16..........	Aug. 29	Aug. 29	2	2.16	15.45	2.89	20.50	....	10.40	62.14	1.085
17..........	Sept. 7	Sept. 5	2	2.06	16.50	3.03	21.59	15.94	11.41	61.05	1.085
18..........	Sept. 17	Sept. 14	2	1.58	16.40	3.77	21.75	....	11.05	54.30	1.085
After 18....	Oct. 10	....	1	2.49	13.37	2.54	18.40	....	8.84	59.13	1.076
After 18....	Oct. 20	....	2	2.71	11.16	4.10	17.97	9.49	4.36	61.38	1.071
After 18....	Oct. 30	....	4	1.39	13.50	4.50	19.39	13.43	7.61	58.06	1.076
After 18....	Nov. 10	....	3	1.79	11.53	3.97	17.29	13.08	5.77	59.86	1.070
After 18....	Nov. 17	....	2	1.97	11.95	3.71	17.63	11.60	6.27	59.17	1.071

IOWA RED TOP.

Jacob Latshaw.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1..........	July 18	July 6	1	2.99	.48	4.12	7.59	....	....	68.27	1.020
2..........	July 6	July 7	1	3.19	.58	1.81	5.58	....	....	68.88	1.020
3..........	July 11	July 9	2	2.99	.97	4.52	8.48	....	....	67.07	1.020
4..........	July 13	July 12	1	3.05	1.11	3.05	7.21	....	....	71.17	1.025
5..........	July 13	July 15	1	3.51	.87	3.41	7.79	....	....	69.63	1.026
6..........	July 15	July 18	1	4.11	.92	2.52	7.55	....	....	68.89	1.027
7..........	July 20	July 19	1	3.73	5.28	2.59	11.60	....	—1.04	70.79	1.043
8..........	July 22	July 20	2	2.93	6.78	3.32	13.03	....	.53	70.70	1.046
9..........	July 25	July 30	2	4.06	5.26	3.19	12.51	5.39	—1.99	69.71	1.044
10..........	July 30	Aug. 2	2	2.97	9.67	2.32	15.96	7.15	4.38	68.63	1.058
11..........	Aug. 5	Aug. 6	1	1.77	11.69	3.31	16.77	11.18	6.61	68.39	1.061
12..........	Aug. 10	Aug. 11	1	1.35	13.72	1.96	17.03	11.43	10.41	57.69	1.068
13..........	Aug. 15	Aug. 15	1	.93	13.83	2.71	17.47	14.04	10.19	64.90	1.073
14..........	Aug. 20	Aug. 19	1	1.08	13.92	3.58	18.58	12.20	9.26	64.28	1.071
15..........	Aug. 25	Aug. 25	1	1.13	17.07	1.77	19.97	....	14.17	54.85	1.082
16..........	Aug. 30	Aug. 30	2	.87	16.27	3.52	20.66	....	11.88	56.21	1.082
17..........	Sept. 6	Sept. 5	2	1.39	17.21	3.29	21.89	16.49	12.53	58.82	1.087
18..........	Sept. 17	Sept. 13	2	.93	16.40	5.44	22.77	....	10.03	58.93	1.082
After 18....	Oct. 10	....	1	1.51	15.34	1.64	18.49	....	12.19	63.79	1.076
After 18....	Oct. 20	....	2	1.43	14.79	2.92	19.14	14.06	10.44	53.97	1.078
After 18....	Oct. 30	....	4	1.83	12.37	3.80	18.09	12.44	6.65	58.11	1.071
After 18....	Nov. 10	....	3	1.60	12.42	4.17	18.19	13.74	6.65	57.81	1.073
After 18....	Nov. 17	....	3	1.23	13.20	3.63	18.06	13.56	8.34	60.50	1.076

NEW VARIETY.

F. W. Stump.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1..........	July 6	July 6	1	3.12	.74	2.21	6.02	....	....	68.48	1.020
2..........	July 18	July 7	1	3.64	.39	4.31	8.34	....	....	70.26	1.025
3..........	July 11	July 9	2	3.08	1.05	3.06	7.19	....	....	72.58	1.023
4..........	July 13	July 11	1	3.29	1.00	3.31	7.60	....	....	73.03	1.025
5..........	July 13	July 13	1	3.33	.41	4.73	8.47	....	....	70.95	1.026
6..........	July 15	July 15	1	4.32	.81	2.37	7.50	....	....	64.20	1.026
7..........	July 19	July 18	1	3.63	4.92	......	8.20	....	....	68.51	1.042
8..........	July 20	July 19	1	3.83	6.00	2.44	11.77	....	.23	69.86	1.045
9..........	July 20	July 20	2	3.45	6.91	3.03	13.89	....	.43	69.66	1.042
10..........	July 26	July 27	5	3.36	7.82	2.85	14.03	7.88	1.61	71.06	1.052
11..........	Aug. 5	July 30	1	1.61	14.54	3.37	19.52	....	9.56	65.42	1.073
12..........	Aug. 10	Aug. 8	2	2.35	13.42	1.76	17.53	12.79	9.81	67.34	1.072
13..........	Aug. 15	Aug. 18	1	1.01	17.19	1.62	19.82	16.41	14.56	61.19	1.082
14..........	Aug. 20	Aug. 19	1	1.15	16.40	3.96	21.51	16.53	11.29	58.41	1.083
15..........	Aug. 25	Aug. 25	1	1.65	17.25	2.28	21.18	....	13.32	61.11	1.086
16..........	Aug. 30	Aug. 30	2	1.12	17.80	3.11	22.03	17.58	13.57	59.43	1.087
17..........	Sept. 6	Sept. 1	2	1.39	18.65	2.81	22.85	18.70	14.45	62.30	1.095
18..........	Sept. 17	Sept. 14	2	.96	18.00	3.16	22.12	....	13.88	57.29	1.090
After 18....	Oct. 10	....	1	1.15	17.18	2.71	21.04	....	13.82	59.39	1.086
After 18....	Oct. 20	....	2	2.14	12.50	4.73	19.37	9.73	5.63	50.55	1.076
After 18....	Oct. 30	....	4	1.24	13.69	3.47	18.40	13.06	8.98	57.58	1.073
After 18....	Nov. 10	....	3	1.46	11.94	3.82	17.22	12.99	6.66	55.18	1.070
After 18....	Nov. 17	....	2	1.75	11.25	4.17	17.17	10.65	5.33	54.09	1.069

EARLY ORANGE.

I. A. Hedges.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
1	July 8	July 15	1	2.45	.81	1.87	5.13	....	....	67.81	[illegible]
2	July 15	July 18	1	3.65	1.85	2.44	7.94	....	....	68.89	[illegible]
3	July 19	July 20	1	4.40	2.11	1.82	7.83	....	....	69.15	[illegible]
4	July 20	July 25	1	5.18	2.05	2.52	9.75	....	....	70.02	[illegible]
5	July 27	July 27	1	5.83	3.24	1.20	10.27	2.17	....	71.01	[illegible]
6	July 30	July 30	2	4.97	7.35	2.64	14.96	5.03	—.26	66.52	[illegible]
7	July 30	Aug. 4	1	5.64	5.23	4.76	15.63	5.21	—5.17	68.09	[illegible]
8	Aug. 10	Aug. 8	1	5.44	10.69	1.67	17.80	13.55	3.58	62.72	[illegible]
9	Aug. 15	Aug. 12	1	2.98	12.39	1.50	16.87	11.91	7.91	66.84	[illegible]
10	Aug. 20	Aug. 15	1	3.61	11.88	3.23	18.72	11.38	5.04	65.39	[illegible]
11	Aug. 25	Aug. 19	1	3.33	15.95	2.81	21.59	15.41	10.31	61.26	[illegible]
12	Aug. 30	Aug. 24	1	2.46	17.26	3.19	22.91	16.74	11.61	58.16	[illegible]
13	Sept. 1	Sept. 1	1	2.51	17.68	2.49	22.68	....	12.68	57.82	[illegible]
14	Sept. 5	Sept. 5	1	5.78	12.78	2.34	20.90	....	5.26	71.41	[illegible]
15	Sept. 9	Sept. 9	1	2.29	17.38	4.94	24.61	....	10.15	55.77	[illegible]
16	Sept. 14	Sept. 12	1	1.54	19.20	2.61	23.35	....	15.05	51.49	[illegible]
18	Sept. 27	Sept. 26	1	1.52	16.57	3.14	21.23	....	11.91	55.84	[illegible]
After 18....	Oct. 10	....	1	1.38	15.81	2.52	19.71	....	11.91	61.86	[illegible]
After 18....	Oct. 20	....	2	1.50	14.71	3.03	19.24	13.96	10.18	59.86	[illegible]
After 18....	Oct. 30	....	4	1.09	13.25	3.96	18.30	12.76	8.20	55.18	[illegible]
After 18....	Nov. 10	....	3	1.33	10.12	3.42	14.87	....	5.87	61.40	[illegible]
After 18....	Nov. 17	....	2	1.37	11.48	4.01	16.86	....	6.10	63.15	[illegible]

EARLY ORANGE.

H. F. D. Daganhardt.

Before 1....	July 8	July 8	1	2.46	.46	3.03	5.95	....	....	64.56	[illegible]
1	July 19	July 18	1	4.59	.76	1.01	6.36	....	....	66.28	[illegible]
2	July 20	July 19	1	5.25	1.76	3.27	10.28	....	....	66.78	[illegible]
3	July 26	July 20	2	6.00	2.77	2.00	10.77	2.18	....	68.89	[illegible]
4	July 28	July 25	1	6.21	4.55	2.29	13.05	3.96	....	67.89	[illegible]
5	July 29	July 27	2	5.90	3.94	1.87	11.71	....	....	68.09	[illegible]
6	July 31	July 30	2	6.12	5.47	3.78	15.37	3.29	....	66.90	[illegible]
7	July 30	Aug. 5	1	5.89	4.88	4.76	15.53	4.37	....	66.72	[illegible]
8	Aug. 10	Aug. 9	1	4.24	13.31	2.43	19.98	13.00	6.64	58.69	[illegible]
9	Aug. 15	Aug. 13	1	3.91	11.62	1.86	17.39	11.21	5.85	66.42	[illegible]
10	Aug. 20	Aug. 19	1	3.98	13.81	3.63	21.42	13.65	6.20	62.26	[illegible]
11	Aug. 25	Aug. 23	1	2.81	16.54	2.52	21.87	16.23	11.21	61.98	[illegible]
12	Aug. 30	Aug. 26	1	2.81	16.95	2.71	22.47	16.57	11.43	50.96	[illegible]
13	Sept. 1	Sept. 1	1	3.56	16.93	3.34	23.83	16.99	10.03	58.01	[illegible]
14	Sept. 5	Sept. 5	1	3.70	13.17	2.64	19.51	12.70	6.83	64.29	[illegible]
15	Sept. 9	Sept. 9	1	2.58	16.46	3.98	23.02	....	9.90	58.05	[illegible]
16	Sept. 14	Sept. 14	1	2.85	17.79	3.55	24.19	....	11.39	56.79	[illegible]
18	Sept. 27	Sept. 27	1	1.39	18.15	4.40	23.94	18.62	12.36	55.99	[illegible]
After 18....	Oct. 10	....	1	1.58	16.72	2.79	21.09	....	12.35	58.86	[illegible]
After 18....	Oct. 20	....	2	1.47	13.33	4.10	18.90	12.98	7.76	56.47	[illegible]
After 18 ...	Oct. 30	....	4	.82	13.29	4.16	18.27	13.11	8.31	57.02	[illegible]
After 18....	Nov. 10	....	3	.93	14.45	4.07	19.45	14.05	9.45	56.13	[illegible]
After 18....	Nov. 17	....	2	1.23	13.15	4.08	18.46	14.11	7.84	56.15	[illegible]

ORANGE CANE.

Fitzgerald.

Before 1....	July 8	July 8	1	2.94	....	2.01	4.95	....	....	[illegible]	[illegible]
1	July 18	July 13	1	4.91	.37	2.13	7.41	....	....	65.06	[illegible]
2	July 18	July 15	1	4.92	.05	2.59	7.97	....	....	[illegible]	[illegible]
3	July 19	July 18	1	4.96	1.12	.84	6.92	....	....	[illegible]	[illegible]
4	July 20	July 20	1	5.26	1.10	2.64	9.00	....	....	71.79	[illegible]
5	July 20	July 23	1	5.51	1.26	2.19	8.96	....	....	71.39	[illegible]
6	July 23	July 25	1	5.06	3.67	3.57	12.30	....	....	70.96	[illegible]

ORANGE CANE—Continued.

FITZGERALD—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
7..........	July 27	July 30	1	5.54	6.33	1.90	13.77	5.86	− 1.11	68.31	1.053
8..........	Aug. 2	Aug. 5	1	4.88	7.85	2.20	14.93	....	.77	68.94	1.058
9..........	Aug. 10	Aug. 9	1	4.15	12.06	.95	17.16	11.22	6.96	65.27	1.069
10..........	Aug. 15	Aug. 15	1	3.66	12.83	1.68	18.17	12.66	7.49	65.78	1.073
11..........	Aug. 20	Aug. 19	1	3.31	15.22	3.58	22.11	15.16	8.33	64.17	1.086
12..........	Aug. 25	Aug. 20	1	3.27	16.34	1.65	21.26	15.31	11.42	57.44	1.087
13..........	Aug. 30	Aug. 26	1	2.97	17.22	2.81	23.00	16.87	11.44	59.96	1.091
14..........	Sept. 1	Sept. 1	1	3.43	17.38	2.79	23.60	16.41	11.16	58.11	1.093
15..........	Sept. 5	Sept. 5	1	3.56	14.12	3.09	20.77	14.60	7.47	65.38	1.083
16..........	Sept. 9	Sept. 11	1	2.00	17.20	4.67	23.87	....	10.53	54.48	1.089
17..........	Sept. 14	Sept. 14	1	2.06	15.79	4.52	22.37	15.13	9.21	60.35	1.084
18..........	Sept. 27	Sept. 27	1	1.56	16.68	5.17	23.41	....	9.95	49.29	1.089
After 18....	Oct. 10	....	1	3.51	10.47	2.01	15.99	9.78	4.95	69.40	1.066
After 18....	Oct. 20	....	2	1.37	15.34	3.87	20.58	13.90	9.90	59.84	1.084
After 18....	Oct. 30	....	4	.98	14.77	4.25	20.00	14.52	9.54	56.74	1.079
After 18....	Nov. 10	....	3	1.13	12.58	3.97	17.68	11.63	7.48	61.14	1.070
After 18....	Nov. 17	....	2	1.36	12.55	3.93	17.84	12.34	7.26	61.32	1.072

NEEAZANA.

BLYMYER & CO.

1..........	July 1	July 11	1	4.24	....	3.11	7.35	....	....	62.21	1.026
2..........	July 10	July 13	2	4.07	.39	3.09	7.55	....	....	66.43	1.025
3..........	July 14	July 15	1	4.55	1.66	2.57	8.78	....	....	66.67	1.030
4..........	July 16	July 16	1	4.97	1.15	3.71	8.83	....	....	70.43	1.036
5..........	July 18	July 18	1	5.48	1.85	.83	8.18	....	....	69.19	1.038
6..........	July 19	July 19	1	5.84	2.78	2.91	11.53	....	....	68.10	1.040
7..........	July 20	July 20	1	5.58	3.76	2.71	12.05	....	....	69.27	1.041
8..........	July 25	July 25	2	5.51	5.84	2.90	14.25	5.46	....	69.59	1.052
9..........	July 28	July 30	2	6.19	5.61	2.26	14.06	5.36	− 2.84	70.99	1.054
10..........	Aug. 1	Aug. 9	1	4.63	9.33	2.44	16.40	8.94	2.26	64.58	1.064
11..........	Aug. 10	Aug. 12	1	3.71	13.24	1.45	18.40	12.98	8.08	60.19	1.076
12..........	Aug. 15	Aug. 15	1	4.67	7.59	1.83	14.09	7.28	1.09	68.70	1.057
13..........	Aug. 20	Aug. 20	1	2.12	13.59	2.40	18.11	....	9.07	62.24	1.071
14..........	Aug. 25	Aug. 25	1	5.04	10.48	.59	16.11	9.03	4.85	61.53	1.065
15..........	Aug. 30	Aug. 30	1	3.46	14.50	2.85	20.81	14.07	8.19	61.96	1.081
16..........	Sept. 1	Sept. 1	1	5.06	9.05	1.47	15.58	8.16	2.52	64.34	1.062
17..........	Sept. 7	Sept. 7	2	5.10	12.65	3.24	21.99	12.12	4.31	61.97	1.079
18..........	Sept. 21	Sept. 21	2	2.28	15.04	3.95	21.27	14.21	8.81	48.91	1.082
After 18....	Oct. 10	....	1	2.67	11.26	3.12	17.05	....	5.37	57.03	1.073
After 18....	Oct. 20	....	2	2.32	11.97	2.55	16.84	10.80	7.10	59.46	1.070
After 18....	Oct. 30	....	3	1.12	12.74	4.04	17.90	12.34	7.58	60.78	1.071
After 18....	Nov. 10	....	3	1.37	12.18	3.02	16.57	11.89	7.79	62.01	1.070
After 18....	Nov. 17	....	3	1.12	13.44	3.29	17.85	12.16	9.03	58.16	1.073

WOLF TAIL.

E. LINK.

1..........	July 8	July 8	1	1.96	1.04	3.37	6.37	....	....	58.70	1.019
2..........	July 20	July 25	1	2.64	3.93	2.34	8.91	....	− 1.05	67.22	1.032
3..........	July 27	Aug. 1	1	3.00	5.62	2.21	10.83	5.84	.41	69.23	1.043
4..........	July 28	Aug. 4	1	2.69	5.96	2.62	11.27	5.92	.65	67.56	1.043
5..........	July 31	Aug. 8	2	3.51	7.13	2.83	13.47	5.21	.79	67.71	1.051
6..........	July 30	Aug. 11	1	2.08	7.93	5.75	15.76	7.75	.10	68.67	1.053
7..........	Aug. 6	Aug. 13	1	2.82	9.62	4.33	16.77	9.92	2.48	66.00	1.061
8..........	Aug. 10	Aug. 15	1	3.16	12.27	.98	16.41	10.78	8.13	65.77	1.066
9..........	Aug. 18	Aug. 17	2	2.39	12.84	2.42	17.65	8.70?	8.03	66.45	1.071
10..........	Aug. 25	Aug. 19	1	2.51	14.69	1.82	19.02	....	10.36	55.92	1.078
11..........	Aug. 30	Aug. 30	1	1.80	16.50	3.20	21.50	....	11.50	59.32	1.086
12..........	Sept. 1	Sept. 1	2	1.61	16.93	3.11	21.65	....	12.21	61.53	1.086
13..........	Sept. 5	Sept. 5	1	3.04	14.41	3.30	20.75	....	8.07	64.82	1.084
14..........	Sept. 9	Sept. 9	1	1.53	16.02	6.49	24.04	....	8.00	62.50	1.094
15..........	Sept. 14	Sept. 14	1	1.09	18.69	6.59	26.37	....	11.01	59.77	1.090

WOLF TAIL—Continued.

E. Link—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
18	Sept. 27	Sept. 27	1	1.03	16.55	4.65	22.23	....	10.87	54.09	[illegible]
After 18	Oct. 10	....	2	1.07	15.85	3.83	20.75	....	10.95	56.31	[illegible]
After 18	Oct. 20	....	1	.51	15.63	3.57	19.71	....	11.55	50.35	[illegible]
After 18	Oct. 30	....	4	.95	13.81	4.02	18.78	13.25	8.84	58.67	[illegible]
After 18	Nov. 10	....	3	.40	14.41	5.27	20.08	15.11	8.74	58.75	[illegible]
After 18	Nov. 17	....	3	.88	12.21	4.18	17.27	....	7.15	59.28	[illegible]

GRAY TOP.

H. C. Sealey.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
Before 1	July 8	July 8	1	1.36	.49	2.83	4.68	....	....	66.67	[illegible]
1	July 16	July 25	1	3.57	.05	2.40	6.02	....	....	61.46	[illegible]
2	July 22	July 30	1	2.57	3.97	1.88	8.42	....	....	66.64	[illegible]
3	July 27	Aug. 1	1	4.12	2.73	2.04	8.89	2.81	....	66.67	[illegible]
4	July 28	Aug. 5	2	3.34	5.41	2.45	11.20	5.06	....	69.90	[illegible]
5	July 31	Aug. 9	2	3.31	6.29	3.38	12.98	2.94	....	67.81	[illegible]
6	Aug. 5	Aug. 13	1	3.88	4.88	3.55	12.66	4.65	−2.60	53.23	[illegible]
7	Aug. 10	Aug. 15	1	4.30	6.22	1.58	12.10	5.11	.34	66.16	[illegible]
8	Aug. 16	Aug. 17	1	3.90	9.18	1.68	14.76	7.77	3.60	64.46	[illegible]
9	Aug. 22	Aug. 18	2	3.65	11.35	1.36	16.36	9.72	6.34	76.90	[illegible]
10	Aug. 20	Aug. 19	1	2.72	14.38	2.89	19.99	13.28	8.77	61.00	[illegible]
11	Aug. 26	Aug. 26	1	4.57	9.65	1.11	15.33	....	3.97	69.65	[illegible]
12	Aug. 30	Aug. 30	1	3.61	12.64	3.05	19.30	12.19	5.98	68.20	[illegible]
13	Sept. 2	Sept. 2	1	1.87	15.97	4.20	22.04	14.79	9.90	60.16	[illegible]
14	Sept. 5	Sept. 5	2	3.00	14.13	3.10	20.23	....	8.03	61.71	[illegible]
15	Sept. 9	Sept. 9	1	4.62	9.65	4.92	19.19	9.42	.11	68.57	[illegible]
16	Sept. 15	Sept. 15	1	1.93	13.96	5.05	20.94	13.56	6.98	59.53	[illegible]
18	Sept. 27	Sept. 27	1	1.83	14.35	3.74	19.92	14.41	8.78	59.45	[illegible]
After 18	Oct. 10	....	2	1.91	14.10	2.91	18.92	....	9.28	61.88	[illegible]
After 18	Oct. 20	....	1	2.74	10.67	2.66	16.07	10.03	5.27	57.46	[illegible]
After 18	Oct. 30	....	4	1.80	11.90	3.44	17.14	11.45	6.66	61.23	[illegible]
After 18	Nov. 10	....	3	1.24	10.19	4.38	15.81	9.79	4.57	61.19	[illegible]
After 18	Nov. 17	....	3	1.72	9.15	4.11	14.98	8.99	3.82	60.83	[illegible]

LIBERIAN.

Blymyer & Co.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
Before 1	July 8	July 8	1	1.92	.28	2.97	5.17	....	....	73.08	[illegible]
1	July 20	July 25	1	4.71	2.41	2.20	9.32	....	....	64.42	[illegible]
2	July 27	July 28	1	5.36	3.08	1.81	10.25	2.78	....	64.83	[illegible]
3	July 28	July 30	2	5.60	4.06	2.16	11.82	3.77	....	66.92	[illegible]
4	Aug. 2	Aug. 3	1	6.28	3.27	2.85	12.40	....	....	68.43	[illegible]
5	Aug. 6	Aug. 5	1	7.26	4.52	2.31	14.09	3.85	....	59.95	[illegible]
6	Aug. 11	Aug. 12	1	6.63	8.32	2.33	17.28	7.20	−.64	68.05	[illegible]
7	Aug. 11	Aug. 15	1	4.37	10.93	3.00	18.30	10.73	3.56	56.36	[illegible]
8	Aug. 16	Aug. 17	1	4.54	11.06	2.58	18.18	10.81	3.94	66.55	[illegible]
9	Aug. 20	Aug. 19	1	4.62	11.99	3.15	19.76	11.83	4.22	64.63	[illegible]
10	Aug. 26	Aug. 26	1	4.07	11.83	1.29	17.19	11.43	6.47	67.01	[illegible]
11	Aug. 30	Aug. 30	1	5.58	11.66	2.30	19.54	10.69	3.78	65.97	[illegible]
12	Sept. 2	Sept. 2	2	1.34	15.88	2.65	19.87	14.69	11.89	63.14	[illegible]
13	Sept. 5	Sept. 5	1	6.74	9.96	2.27	18.97	9.43	.95	67.77	[illegible]
14	Sept. 9	Sept. 9	1	4.71	13.00	3.65	21.36	13.19	4.64	67.62	[illegible]
15	Sept. 15	Sept. 15	1	2.94	14.23	4.41	21.58	14.81	6.88	59.04	[illegible]
18	Sept. 27	Sept. 27	1	2.10	16.22	3.10	21.42	....	11.02	54.72	[illegible]
After 18	Oct. 10	....	2	2.37	14.11	3.43	19.91	....	8.31	58.16	[illegible]
After 18	Oct. 20	....	1	3.60	11.80	2.76	18.16	11.50	5.44	56.89	[illegible]
After 18	Oct. 30	....	4	2.59	9.71	3.74	16.04	8.69	2.88	61.06	[illegible]
After 18	Nov. 10	....	3	2.72	10.93	4.18	17.83	10.92	4.03	60.60	[illegible]
After 18	Nov. 17	....	3	2.32	10.46	3.97	16.75	9.47	4.17	57.13	[illegible]

MASTODON.

D. W. Aiken.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
1	July 7	July 15	1	1.84	.32	2.17	4.33	....	....	65.67	1.016
2	July 16	July 25	1	3.73	1.15	3.14	8.02	....	....	68.55	1.028
3	July 26	July 30	2	3.40	3.79	2.12	9.31	2.92	....	66.38	1.035
4	July 31	Aug. 2	2	4.31	2.97	3.04	10.32	....	....	68.99	1.035
5	Aug. 6	Aug. 6	1	4.62	4.75	1.25	10.62	3.89	—1.12	69.55	1.040
6	Aug. 11	Aug. 15	1	4.21	8.07	1.96	14.24	7.75	1.90	68.43	1.053
7	Aug. 16	Aug. 17	1	6.01	4.41	1.96	12.38	3.74	—3.56	69.07	1.049
8	Aug. 16	Aug. 19	1	3.47	7.75	2.93	14.15	7.44	1.35	69.76	1.053
9	Aug. 22	Aug. 22	1	4.25	8.98	1.48	14.71	8.06	3.25	66.23	1.057
10	Aug. 26	Aug. 26	1	6.09	4.66	1.00	11.75	4.14	—2.43	66.26	1.046
11	Aug. 30	Aug. 30	1	1.45	14.80	2.96	19.16	13.88	10.39	58.62	1.075
12	Sept. 2	Sept. 2	1	1.20	15.48	2.85	19.53	13.47	11.43	64.81	1.072
13	Sept. 5	Sept. 5	1	4.24	11.89	2.58	18.71	11.50	5.07	65.58	1.074
14	Sept. 9	Sept. 9	2	1.51	14.43	2.98	18.92	13.35	9.94	66.00	1.073
15	Sept. 15	Sept. 15	1	2.64	11.31	5.03	18.98	....	3.64	60.07	1.064
18	Sept. 27	Sept. 27	1	.70	16.07	3.50	20.27	....	11.87	50.63	1.080
After 18	Oct. 10	....	2	1.42	12.68	2.98	17.08	....	8.28	57.21	1.068
After 18	Oct. 20	....	1	3.45	5.54	2.73	11.72	5.48	—.64	61.27	1.049
After 18	Oct. 30	....	4	2.20	10.37	3.31	15.88	10.10	4.86	63.77	1.062
After 18	Nov. 10	....	3	2.49	6.93	4.57	13.99	7.01	—.18	64.29	1.054
After 18	Nov. 17	....	3	1.87	9.53	3.69	15.09	9.58	3.97	64.55	1.061

HONDURAS.

E. Link.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
Before 1	July 22	July 22	3	4.02	1.12	2.29	7.43	.87	....	62.76	1.026
1	Aug. 2	July 30	1	5.03	1.51	3.60	10.14	....	....	69.97	1.035
2	Aug. 11	Aug. 5	1	5.04	5.04	1.78	11.86	4.18	....	70.99	1.045
3	Aug. 11	Aug. 10	1	6.25	3.88	1.74	11.87	3.11	....	68.89	1.044
4	Aug. 11	Aug. 16	1	5.21	4.19	2.58	11.98	3.72	....	63.78	1.043
5	Aug. 16	Aug. 17	1	6.12	5.89	1.93	17.94	5.24	....	69.21	1.055
6	Aug. 16	Aug. 19	1	6.04	5.96	1.75	13.75	5.68	—1.83	71.41	1.055
7	Aug. 22	Aug. 22	2	4.38	9.89	1.79	16.06	8.88	3.72	66.70	1.062
8	Aug. 26	Aug. 26	1	5.86	8.30	1.29	15.45	7.98	1.15	66.70	1.061
9	Aug. 30	Aug. 30	1	4.31	11.89	1.99	18.19	11.14	5.59	62.82	1.072
10	Sept. 2	Sept. 2	2	3.32	13.82	2.39	19.53	13.12	8.11	65.18	1.075
11	Sept. 5	Sept. 5	1	3.26	13.45	1.92	18.63	11.65	8.27	67.92	1.073
12	Sept. 9	Sept. 9	2	5.10	9.66	2.76	17.52	8.63	1.80	71.20	1.065
13	Sept. 15	Sept. 15	1	2.55	14.23	5.43	22.21	13.74	6.25	59.56	1.076
18	Sept. 27	Sept. 27	1	2.56	13.58	2.53	18.67	12.77	8.39	62.85	1.072
After 18	Oct. 10	....	2	3.54	9.60	2.86	16.00	....	3.20	62.29	1.064
After 18	Oct. 20	....	1	4.52	6.77	2.10	13.39	6.60	.15	63.11	1.056
After 18	Oct. 30	....	4	3.94	6.11	3.10	13.15	5.99	—.93	63.51	1.052
After 18	Nov. 10	....	3	3.57	6.28	3.61	13.46	6.06	—.90	64.08	1.052
After 18	Nov. 17	....	3	2.91	5.62	3.58	12.11	5.13	—.87	65.25	1.048

SUGAR CANE.

C. E. Miller.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 16	July 5	1	4.81	3.41	3.64	11.86	....	....	71.12	1.038
2	July 7	July 7	1	3.48	.27	4.99	8.74	....	....	73.52	1.023
3	July 9	July 9	1	3.56	.67	3.15	7.38	....	....	69.16	1.023
4	July 13	July 11	2	3.40	1.06	4.00	8.46	....	....	70.79	1.025
5	July 13	July 13	2	3.45	1.62	3.70	8.77	....	....	65.58	1.028
6	July 16	July 15	1	4.36	.73	2.34	7.43	....	....	65.90	1.029
7	July 18	July 18	1	4.43	4.95	1.19	10.57	....	....	62.95	1.045
8	July 19	July 20	1	4.90	3.74	3.32	11.96	....	....	71.38	1.045
9	July 21	July 25	2	4.52	5.77	2.66	12.95	....	—1.41	65.85	1.048

SUGAR CANE—Continued.

C. E. MILLER—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
10	July 27	July 30	1	3.92	6.63	1.97	12.52	6.23	.74	68.42	[illegible]
11	Aug. 2	Aug. 4	1	3.44	6.31	5.24	14.99	....	—2.87	69.48	[illegible]
12	Aug. 2	Aug. 8	1	3.24	4.00	2.91	10.15	....	—2.15	67.83	[illegible]
13	Aug. 16	Aug. 15	1	3.58	9.57	2.92	16.07	....	3.07	66.85	[illegible]
14	Aug. 22	Aug. 19	1	2.62	13.56	2.23	18.41	12.92	8.71	66.60	[illegible]
15	Aug. 26	Aug. 26	1	3.56	12.27	2.48	18.31	12.25	6.23	67.00	[illegible]
16	Aug. 30	Aug. 30	1	1.73	15.49	3.45	20.67	14.80	10.31	54.94	[illegible]
17	Sept. 4	Sept. 4	2	2.95	15.15	2.15	20.25	11.09	10.05	62.06	[illegible]
18	Sept. 21	Sept. 21	8	4.07	10.82	3.79	18.68	10.59	2.96	61.48	[illegible]
After 18	Oct. 10	....	2	2.06	13.20	3.72	18.98	....	7.42	57.04	[illegible]
After 18	Oct. 20	....	1	1.22	13.32	3.08	17.62	....	9.02	50.16	[illegible]
After 18	Oct. 30	....	4	3.06	8.06	3.50	14.62	8.72	1.50	58.17	[illegible]
After 18	Nov. 10	....	3	1.86	7.26	3.91	13.03	7.09	1.40	62.34	[illegible]
After 18	Nov. 17	....	3	3.24	7.82	3.29	14.35	7.44	1.29	59.92	[illegible]

HYBRID No. 4.

WILL N. WALLIS.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 7	July 6	2	2.94	.32	2.27	5.53	....	....	68.13	[illegible]
2	July 12	July 9	1	3.06	.37	2.85	6.28	....	....	71.46	[illegible]
3	July 12	July 11	1	3.37	.06	2.31	6.18	....	....	71.25	[illegible]
4	July 14	July 12	1	3.49	.11	5.95	9.55	....	....	73.29	[illegible]
5	July 16	July 15	1	4.74	.23	3.24	8.21	....	....	71.43	[illegible]
6	July 16	July 18	1	4.67	.13	3.55	8.35	....	....	70.01	[illegible]
7	July 18	July 20	1	5.07	1.56	1.59	8.22	....	....	66.38	[illegible]
8	July 21	July 25	2	5.47	2.01	3.16	10.64	....	....	66.38	[illegible]
9	July 22	July 28	1	5.11	3.81	2.85	11.77	....	....	70.03	[illegible]
10	July 27	July 30	1	4.96	5.75	1.73	12.44	5.62	—.94	70.37	[illegible]
11	Aug. 7	Aug. 9	4	4.34	8.40	2.66	15.40	8.14	1.40	67.37	[illegible]
12	Aug. 11	Aug. 15	1	3.34	11.66	2.37	17.37	11.25	5.95	69.05	[illegible]
13	Aug. 16	Aug. 19	1	3.27	12.20	2.43	17.90	11.43	6.60	60.25	[illegible]
14	Aug. 22	Aug. 22	1	3.00	12.78	2.18	17.96	12.04	7.60	65.00	[illegible]
15	Aug. 26	Aug. 26	1	3.43	13.39	.66	17.48	12.70	9.30	65.06	[illegible]
16	Aug. 30	Aug. 30	1	2.66	14.22	2.71	19.59	13.88	8.85	57.92	[illegible]
17	Sept. 3	Sept. 3	2	2.51	15.82	3.11	21.44	14.40	10.20	60.57	[illegible]
18	Sept. 13	Sept. 12	2	3.99	12.35	2.98	19.32	11.62	5.38	62.51	[illegible]
After 18	Oct. 10	....	2	4.06	9.10	2.85	16.01	8.09	2.19	61.72	[illegible]
After 18	Oct. 20	....	1	4.12	6.77	2.47	13.36	6.06	.18	55.68	[illegible]
After 18	Oct. 30	....	4	3.43	6.94	3.29	13.66	6.86	.22	61.39	[illegible]
After 18	Nov. 10	....	3	4.06	6.25	3.04	13.35	5.41	—.85	60.17	[illegible]
After 18	Nov. 17	....	3	2.82	6.04	3.59	12.45	4.40	—.87	61.05	[illegible]

WHITE IMPHEE.

JOHN N. BARGER.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
Before 1	July 7	July 7	1	2.38	.39	2.37	5.14	....	....	63.49	[illegible]
1	July 13	July 15	1	3.45	1.06	2.31	6.82	....	....	60.81	[illegible]
2	July 16	July 18	1	4.12	.90	3.18	8.15	....	....	67.33	[illegible]
3	July 21	July 20	2	4.21	2.42	3.21	9.84	....	....	67.54	[illegible]
4	July 22	July 25	1	4.22	3.55	2.01	9.78	....	—2.68	71.07	[illegible]
5	July 26	July 28	2	3.97	5.64	1.92	10.53	4.91	—.25	68.56	[illegible]
6	July 29	July 30	1	4.68	7.41	2.42	14.51	7.45	.31	68.36	[illegible]
7	Aug. 2	Aug. 5	1	3.01	8.85	4.85	16.71	....	.99	66.79	[illegible]
8	Aug. 8	Aug. 10	2	3.32	12.90	2.70	18.92	12.15	6.88	61.16	[illegible]
9	Aug. 16	Aug. 15	1	2.57	12.49	1.84	16.90	11.28	8.08	66.91	[illegible]
10	Aug. 22	Aug. 19	1	2.74	8.58?	1.62	12.94	7.89	4.22?	70.02	[illegible]
11	Aug. 26	Aug. 26	1	1.77	15.52	1.67	18.96	15.05	12.08	64.60	[illegible]
12	Aug. 30	Aug. 30	1	1.15	16.85	3.25	21.25	16.34	12.45	58.33	[illegible]
13	Sept. 2	Sept. 2	1	1.47	14.97	3.57	20.01	....	9.93	65.05	[illegible]
14	Sept. 5	Sept. 5	1	1.20	18.24	2.25	21.69	17.14	14.79	60.95	[illegible]
15	Sept. 9	Sept. 9	1	1.48	19.25	2.41	23.14	....	15.36	61.06	[illegible]
16	Sept. 15	Sept. 15	1	.86	16.73	4.38	21.97	....	11.49	57.02	[illegible]

WHITE IMPHEE—Continued.

JOHN N. BARGER—Continued.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
After 18....	Oct. 10	....	1	1.20	16.35	4.15	21.70	....	11.00	56.77	1.085
After 18....	Oct. 20	....	2	1.57	8.05	4.08	12.70	7.68	3.40	63.58	1.050
After 18....	Oct. 30	....	4	1.75	8.41	3.55	13.71	7.29	3.11	63.09	1.054
After 18....	Nov. 10	....	3	1.42	6.49	3.44	11.35	6.54	1.63	61.16	1.046
After 18....	Nov. 15	....	2	1.99	6.50	3.33	11.91	6.28	1.27	61.83	1.048

GOOSE NECK.

G. N. GIBSON.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
Before 1...	July 9	July 9	1	1.91	.93	3.12	5.12	....	....	69.35	1.014
1	July 13	July 15	1	2.86	.24	2.38	5.48	....	....	62.62	1.021
2	July 13	July 18	1	2.98	.31	1.87	5.16	....	....	65.14	1.017
3	July 13	July 20	1	2.88	....	3.23	6.11	....	....	65.29	1.020
4	July 22	July 25	1	4.78	1.65	1.70	8.13	....	....	69.29	1.032
5	July 28	July 26	2	5.31	3.70	1.47	10.48	2.76	....	64.60	1.039
6	July 29	July 28	1	4.89	4.99	2.54	12.42	4.28	....	58.45	1.046
7	Aug. 2	July 30	1	3.35	7.48	4.83	15.66	....	— .70	62.36	1.053
8	Aug. 8	Aug. 4	2	5.23	8.07	1.77	15.07	6.63	1.07	66.04	1.056
9	Aug. 11	Aug. 8	1	4.46	10.25	1.76	16.47	9.14	4.03	64.26	1.065
10	Aug. 17	Aug. 12	1	2.05	11.59	4.34	17.98	....	5.20	58.71	1.065
11	Aug. 22	Aug. 15	1	3.28	11.16	2.35	16.79	10.68	5.53	65.32	1.066
12	Aug. 26	Aug. 19	1	2.21	13.14	2.58	17.93	12.32	8.35	46.09	1.068
13	Aug. 30	Aug. 30	1	1.89	13.85	2.39	18.13	....	9.57	61.14	1.070
14	Sept. 2	Sept. 2	1	2.07	15.18	3.10	20.35	13.47	10.01	60.84	1.076
15	Sept. 5	Sept. 5	1	1.33	15.59	2.09	19.01	....	12.17	57.84	1.078
16	Sept. 9	Sept. 9	1	1.83	16.00	2.00	19.83	....	12.17	60.10	1.077
17	Sept. 15	Sept. 15	1	1.21	14.37	5.27	20.85	....	7.89	57.58	1.079
After 18....	Oct. 10	....	1	1.50	14.86	3.27	19.63	....	10.09	52.94	1.082
After 18....	Oct. 20	....	2	1.94	12.40	2.94	15.28	10.79	7.52	60.88	1.073
After 18....	Oct. 30	....	4	1.59	12.11	3.74	17.44	11.78	6.78	61.12	1.069
After 18....	Nov. 10	....	3	2.71	6.74	3.63	13.08	8.51	.40	60.16	1.052
After 18....	Nov. 15	....	2	2.29	8.31	2.74	13.34	....	3.28	57.11	1.054

WHITE AFRICAN.

JOHN N. BARGER.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 6	July 6	1	2.39	.41	2.26	5.06	....	....	65.13	1.017
2	July 16	July 9	1	3.66	.98	5.02	9.66	....	....	71.62	1.024
3	July 9	July 12	1	2.51	.35	5.28	8.14	....	....	69.83	1.019
4	July 13	July 15	1	2.99	.62	2.00	5.61	....	....	67.50	1.024
5	July 15	July 16	1	3.35	1.54	3.52	8.41	....	....	68.09	1.028
6	July 15	July 18	1	3.70	.81	2.43	6.94	....	....	67.66	1.023
7	July 21	July 20	2	3.96	.26	4.70	8.92	....	....	67.66	1.037
8	July 22	July 25	1	3.85	4.29	1.96	10.10	....	—1.52	67.85	1.039
9	Aug. 2	July 28	1	2.42	9.27	2.20	13.89	....	4.65	65.17	1.058
10	Aug. 3	July 30	1	2.25	8.11	4.15	14.51	....	1.71	65.08	1.054
11	Aug. 11	Aug. 5	1	3.10	11.32	2.88	17.30	10.94	5.34	65.43	1.066
12	Aug. 17	Aug. 10	1	2.03	13.36	3.24	18.63	....	8.09	61.75	1.073
13	Aug. 22	Aug. 15	1	2.00	14.25	2.24	18.49	13.30	10.01	60.34	1.073
14	Aug. 26	Aug. 19	1	1.80	14.44	2.04	18.28	14.28	10.60	52.33	1.072
15	Aug. 31	Aug. 30	1	1.32	15.89	2.53	19.74	....	12.04	54.36	1.079
16	Sept. 2	Sept. 1	1	1.50	15.45	4.27	21.22	....	9.68	60.22	1.079
17	Sept. 7	Sept. 5	2	1.83	15.76	2.75	20.34	....	11.18	58.59	1.078
18	Sept. 15	Sept. 12	1	1.33	14.62	4.47	20.42	....	8.82	61.09	1.077
After 18....	Oct. 10	....	1	1.42	13.50	3.34	18.27	....	8.73	39.57	1.078
After 18....	Oct. 20	....	2	1.07	12.75	4.33	18.15	....	7.35	59.49	1.072
After 18....	Oct. 30	....	4	1.24	12.81	3.96	18.01	12.66	7.61	56.67	1.072
After 18....	Nov. 10	....	3	1.19	10.77	4.65	16.61	10.56	4.93	57.33	1.067
After 18....	Nov. 15	....	2	1.18	12.12	3.64	16.74	12.80	7.50	57.32	1.068

WEST INDIA SUGAR CANE.

D. C. SNOW.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
1	July 28	July 25	2	5.98	1.87	1.77	9.62	1.28	....	67.72	1.066
2	July 29	Aug. 1	2	5.40	3.14	2.75	11.29	2.81	....	63.25	1.049
3	Aug. 1	Aug. 3	2	5.24	3.95	3.26	12.45	3.23	....	64.09	1.045
4	Aug. 3	Aug. 5	1	5.06	5.27	......	....	....	....	69.75	1.054
5	Aug. 6	Aug. 8	1	5.69	6.91	2.58	15.18	6.60	....	65.02	1.064
6	Aug. 17	Aug. 11	1	4.00	11.18	1.27	16.45	10.69	5.91	61.05	1.070
7	Aug. 22	Aug. 14	1	3.25	14.07	2.04	19.36	13.01	8.78	63.27	1.075
8	Aug. 26	Aug. 16	1	3.34	14.86	2.43	20.63	14.41	9.09	53.10	1.083
9	Aug. 31	Aug. 19	1	2.53	15.78	2.09	20.40	15.26	11.16	67.18	1.083
10	Sept. 2	Aug. 30	1	1.89	17.44	4.33	23.66	17.74	11.22	60.86	1.088
11	Sept. 5	Sept. 2	1	2.30	17.64	2.94	22.88	15.18	12.40	62.61	[illegible]
12	Sept. 9	Sept. 7	1	1.70	18.87	3.07	23.64	....	14.10	62.56	1.087
13	Sept. 15	Sept. 11	1	2.54	14.47	4.26	21.27	....	7.67	57.55	1.082
After 18....	Oct. 4	Oct. 2	1	1.37	15.78	3.22	20.37	....	11.19	56.02	1.085

SUGAR CANE.

JOHN N. BARGER.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 6	July 6	1	3.19	.28	1.78	5.25	....	....	69.72	1.019
2	July 16	July 8	1	3.73	.30	1.87	5.90	....	....	67.46	1.024
3	July 9	July 9	1	3.21	.24	2.96	6.41	....	....	70.13	1.021
4	July 13	July 12	1	3.01	....	2.23	5.24	....	....	68.01	1.020
5	July 13	July 15	1	4.23	....	2.49	6.72	....	....	68.79	1.026
6	July 15	July 16	1	4.19	.37	3.71	8.27	....	....	67.90	1.031
7	July 16	July 18	1	4.76	.71	2.77	8.24	....	....	72.29	1.031
8	July 18	July 20	1	4.62	4.76	......	8.05?	....	....	64.53	1.037
9	July 22	July 30	1	4.84	3.94	2.35	11.13	....	....	69.50	1.042
10	Aug. 3	Aug. 8	1	4.10	6.62	3.07	13.79	....	....	65.73	1.051
11	Aug. 11	Aug. 15	1	4.92	3.19	3.04	11.15	3.69	—1.34	66.36	1.040
12	Aug. 17	Aug. 19	1	4.30	9.09	1.71	15.10	....	3.08	71.32	1.050
13	Aug. 22	Aug. 20	1	4.06	5.67	1.98	11.71	4.20	— .37	68.62	1.046
14	Aug. 26	Aug. 24	1	3.35	11.57	1.57	16.49	10.89	6.65	62.55	1.067
15	Aug. 31	Aug. 30	1	3.73	11.55	3.50	18.78	10.48	4.32	65.35	1.070
16	Sept. 2	Sept. 1	1	3.78	11.27	2.43	17.48	9.32	5.06	67.18	1.064
17	Sept. 7	Sept. 7	2	2.96	16.43	2.20	21.59	14.90	11.27	60.24	1.050
18	Sept. 15	Sept. 15	1	2.57	13.38	4.30	20.25	12.99	6.51	68.81	1.074
After 18....	Oct. 4	Oct. 30	1	2.26	12.97	2.21	17.44	12.68	8.50	61.05	1.075

NEW VARIETY OF LIBERIAN AND OOMSEEANA.

JOHN N. BARGER.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 16	July 5	1	3.78	.78	2.81	7.37	....	....	67.54	1.024
2	July 7	July 7	1	3.44	....	2.44	5.88	....	....	66.47	1.026
3	July 9	July 8	1	3.06	.46	3.14	6.66	....	....	65.00	1.021
4	July 13	July 12	1	4.02	.23	2.57	6.82	....	....	64.25	1.025
5	July 13	July 15	1	4.71	.48	2.48	7.67	....	....	66.58	1.029
6	July 16	July 18	1	4.77	.18	1.99	6.94	....	....	67.86	1.030
7	July 18	July 20	1	4.89	1.67	3.68	10.24	....	....	76.81	1.035
8	July 21	July 25	2	5.14	4.28	3.80	13.22	....	....	66.20	1.043
9	July 25	July 30	2	4.75	5.73	2.44	12.92	2.93	....	65.99	1.045
10	Aug. 1	Aug. 5	2	4.21	7.90	3.66	15.77	7.66	.03	66.93	1.057
11	Aug. 12	Aug. 8	1	3.10	12.30	2.22	17.62	11.76	6.98	59.39	1.067
12	Aug. 17	Aug. 15	1	3.02	13.03	3.20	19.25	12.71	6.81	66.78	1.075
13	Aug. 22	Aug. 19	1	3.18	12.88	2.67	18.73	11.55	7.03	52.47	1.073
14	Aug. 26	Aug. 24	1	3.15	14.03	1.28	18.46	12.62	9.60	72.04	1.075
15	Aug. 31	Aug. 29	1	3.21	13.55	2.86	19.62	13.11	7.48	60.44	1.078
16	Sept. 2	Aug. 30	1	1.98	16.06	4.23	22.27	15.72	9.85	56.53	1.082
17	Sept. 7	Sept. 3	2	2.48	15.83	3.51	21.82	14.79	9.81	59.11	1.088
18	Sept. 15	Sept. 14	1	2.14	14.70	3.28	20.12	14.04	9.28	58.64	1.076
After 18....	Oct. 4	Sept. 28	1	2.17	12.57	2.53	17.27	12.29	7.87	55.23	1.071

MINNESOTA EARLY AMBER.

VILMORIN.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
1	July 6	July 6	1	3.15	.32	1.85	5.30	....	—4.68	68.90	1.018
2	July 16	July 8	1	2.75	5.84	2.69	11.28	....	.39	66.51	1.041
3	July 10	July 9	2	3.25	.69	2.38	6.82	....	—4.94	68.29	1.023
4	July 13	July 11	1	3.17	.81	2.21	6.29	....	....	71.71	1.024
5	July 13	July 15	1	3.22	.32	2.08	5.62	....	....	70.32	1.021
6	July 13	July 16	1	3.45	1.99	1.09	6.53	....	....	66.72	1.026
7	July 16	July 18	1	3.38	.39	4.56	8.33	....	—7.55	72.77	1.034
8	July 18	July 19	1	.96	6.86	1.31	9.13	....	4.59	72.00	1.040
9	July 20	July 20	4	3.27	6.91	2.42	12.60	....	1.22	71.08	1.045
10	July 27	July 25	2	2.64	10.50	2.24	15.38	10.81	5.62	63.98	1.060
11	Aug. 1	Aug. 5	2	2.27	11.26	4.59	18.12	8.96	4.40	65.80	1.065
12	Aug. 12	Aug. 8	1	1.47	15.40	1.76	18.63	14.19	12.17	64.60	1.060
13	Aug. 17	Aug. 15	1	1.51	15.64	4.08	21.23	....	10.05	58.93	1.081
14	Aug. 22	Aug. 19	1	1.56	14.72	3.00	19.28	....	10.16	79.48	1.076
15	Aug. 26	Aug. 23	1	1.34	15.77	2.45	19.56	....	11.98	60.19	1.081
16	Aug. 31	Aug. 28	1	1.19	15.98	2.75	19.92	....	12.04	59.49	1.079
17	Sept. 8	Aug. 30	2	1.10	16.46	3.30	20.86	15.18	12.06	59.28	1.078
18	Sept. 12	Sept. 9	2	1.62	13.71	3.86	19.29	....	8.23	60.08	1.071
After 18....	Oct. 4	Sept. 30	1	1.59	13.55	2.39	17.53	13.41	9.57	56.92	1.072

HOLCUS SACCHARATUS.

VILMORIN.

1	July 13	July 12	1	1.03	.56	2.79	4.38	....	....	64.12	1.016
2	July 16	July 15	1	2.88	....	2.95	5.83	....	....	72.98	1.020
3	July 22	July 18	1	1.82	1.76	3.34	6.92	....	....	66.97	1.025
4	Aug. 3	July 25	1	1.27	2.81	4.01	8.09	....	....	56.27	1.032
5	Aug. 12	July 30	1	2.10	3.84	3.21	9.15	....	....	48.17	1.038
6	Aug. 12	Aug. 3	1	2.50	2.82	4.47	9.88	3.02	....	41.86	1.037
7	Aug. 12	Aug. 10	1	2.76	3.18	4.28	10.22	....	....	42.72	1.038
8	Aug. 17	Aug. 15	1	2.48	7.64	3.46	13.58	5.61	1.70	50.38	1.056
9	Aug. 22	Aug. 19	1	2.27	7.95	3.73	13.95	6.99	1.95	42.91	1.057
10	Aug. 26	Aug. 26	1	2.10	7.23	3.27	12.60	5.55	1.86	44.44	1.051
11	Aug. 31	Aug. 31	1	1.57	5.53	4.83	11.93	....	....	44.55	1.047
12	Sept. 2	Sept. 1	1	.87	3.87	5.58	10.32	8.98?	....	46.42	1.042
13	Sept. 5	Sept. 4	1	1.55	4.72	4.81	11.08	3.81	....	48.10	1.046
14	Sept. 10	Sept. 8	1	1.37	4.83	5.27	11.47	4.56	....	48.48	1.046
15	Sept. 15	Sept. 13	1	1.49	5.69	10.54	17.72	....	....	47.93	1.051
After 18....	Oct. 5	Sept. 30	1	.53	7.81	4.37	12.71	....	2.91	44.82	1.058

HOLCUS SORGHUM.

VILMORIN.

Before 1....	July 7	July 5	2	1.08	.91	2.46	4.45	....	....	63.14	1.017
1	July 16	July 12	1	1.04	1.18	3.17	5.39	....	....	56.95	1.020
2	July 13	July 15	1	.67	.38	2.97	4.02	....	....	52.09	1.018
3	July 16	July 16	1	1.04	.46	3.81	4.90	....	....	59.67	1.020
4	July 18	July 17	1	3.55	....	1.35	4.90	....	....	63.66	1.020
5	July 19	July 18	1	1.03	1.62	3.20	5.85	....	....	56.29	1.025
6	July 21	July 25	2	.94	1.46	1.91	4.31	....	....	47.36	1.021
7	July 31	July 30	2	1.20	3.47	4.86	9.53	3.16	....	47.46	1.032
8	Aug. 12	Aug. 10	1	1.51	2.94	3.96	8.41	....	....	48.60	1.034
9	Aug. 17	Aug. 20	1	1.00	5.32	4.16	10.48	3.87	.16	43.67	1.044
10	Aug. 23	Aug. 22	1	.81	4.24	4.31	9.36	3.79	....	43.80	1.042
11	Aug. 27	Aug. 23	1	.87	3.08	3.81	7.76	2.29	....	36.66	1.031
12	Aug. 31	Aug. 28	1	.92	10.17	4.13	15.22	....	5.12	34.98	1.064
13	Sept. 2	Sept. 1	1	.87	8.82	6.28	15.97	8.32	1.67	38.27	1.058
14	Sept. 5	Sept. 4	1	.90	11.04	4.69	16.63	....	5.45	51.13	1.064
15	Sept. 10	Sept. 9	1	.82	8.77	5.07	14.66	8.62	2.98	41.95	1.057
16	Sept. 15	Sept. 13	1	.81	4.14	6.06	11.01	....	....	47.75	1.044
After 18....	Oct. 5	Sept. 30	1	.05	3.18	4.04	7.27	6.82?	....	35.01	1.038

HOLCUS CERNUS, WHITE.

Vilmorin.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
Before 1....	July 6	July 6	1	1.07	.37	2.44	3.88	....	....	59.91	1.016
1..........	July 18	July 12	1	.85	2.05	2.51	5.41	....	....	50.56	1.027
2..........	July 12	July 15	2	1.18	.53	3.01	4.72	....	....	54.45	1.018
3..........	July 21	July 25	2	1.39	2.37	2.18	5.94	....	....	53.73	1.026
4..........	July 26	July 26	1	.98	2.72	3.19	6.89	....	—1.45	54.63	1.030
5..........	Aug. 3	July 28	1	1.65	7.67	4.26	13.58	....	1.76	44.36	1.056
6..........	Aug. 12	July 30	1	1.64	6.14	4.44	12.22	5.80	.06	41.34	1.047
7..........	Aug. 12	Aug. 3	1	1.85	5.96	4.51	12.32	1.94!	—.40	48.80	1.047
8..........	Aug. 12	Aug. 12	1	.77	7.74	4.60	13.11	7.08	2.37	53.86	1.052
9..........	Aug. 17	Aug. 19	1	.99	10.39	5.13	16.51	....	4.26	47.96	1.063
10..........	Aug. 23	Aug. 22	1	.60	9.34	3.56	13.50	....	5.18	49.51	1.055
11..........	Aug. 27	Aug. 28	1	.94	10.28	5.89	16.91	10.26	3.45	50.10	1.062
12..........	Aug. 31	Aug. 30	1	1.16	12.16	5.13	18.45	....	4.87	34.49	1.070
13..........	Sept. 2	Sept. 1	1	.62	14.58	4.24	19.44	....	9.72	49.29	1.075
14..........	Sept. 7	Sept. 7	1	.99	12.57	4.19	17.75	....	7.39	32.36	1.073
15..........	Sept. 10	Sept. 9	1	2.53	11.96	4.83	19.32	....	4.60	33.88	1.074
17..........	Sept. 17	Sept. 15	1	.68	13.61	4.31	18.60	....	8.62	45.27	1.075
After 18....	Oct. 5	Sept. 30	1	.47	11.49	4.89	16.85	....	6.13	57.27	1.062

HONEY CANE.

J. H. Clark.

1..........	July 13	July 15	1	1.78	....	2.45	4.23	....	....	71.39	1.016
2..........	Aug. 6	July 30	1	4.61	2.53	1.16	8.30	1.78	....	68.21	[illegible]
3..........	Aug. 6	Aug. 3	1	4.61	2.38	1.12	8.11	1.31	....	71.44	1.029
4..........	Aug. 12	Aug. 12	1	5.19	2.64	2.50	10.33	1.85	....	72.28	1.035
5..........	Aug. 12	Aug. 15	1	5.89	2.63	2.30	10.82	5.45?	—5.56	71.70	[illegible]
6..........	Aug. 17	Aug. 17	1	4.17	7.30	1.19	12.66	6.26	1.94	71.23	1.050
7..........	Aug. 23	Aug. 19	2	4.47	8.34	2.09	14.90	7.90	1.68	66.81	1.056
8..........	Aug. 27	Aug. 23	2	3.49	6.29	3.94	13.72	6.43	—1.14	66.13	1.049
9..........	Aug. 31	Aug. 25	1	4.47	7.08	2.51	14.06	6.66	.10	71.94	1.053
10..........	Sept. 2	Aug. 30	1	5.49	9.02	2.36	16.87	7.90	1.17	66.54	1.061
11..........	Sept. 7	Sept. 3	2	5.19	8.52	1.48	15.19	7.37	1.75	69.64	1.059
12..........	Sept. 10	Sept. 7	1	5.68	6.97	2.32	14.97	5.95	—1.03	69.08	1.055
17..........	Sept. 17	Sept. 15	1	2.83	13.07	2.09	17.99	12.59	8.15	61.62	1.070
After 18....	Oct. 5	Sept. 30	1	1.64	10.95	2.09	14.68	10.95	7.22	57.68	1.065

EGYPTIAN SUGAR CORN.

	June 13	June 13	1	.94	.25	1.92	2.11	....	....	67.30	1.016
Before 1....	June 20	June 20	1	1.17	.47	1.52	3.16	....	....	69.10	1.014
2..........	June 27	June 27	1	2.20	.16	1.31	3.67	....	....	78.10	1.015
3..........	July 10	July 5	2	2.33	.37	2.81	5.51	....	....	66.82	1.018
4..........	July 16	July 9	1	1.32	.74	4.90	6.96	....	....	64.07	1.019
5..........	July 11	July 11	1	2.38	.81	2.19	5.38	....	....	66.96	1.021
6..........	July 18	July 15	1	2.40	2.12	2.30	6.91	....	....	64.56	1.027
7..........	July 18	July 18	1	3.29	.89	1.38	5.56	....	....	63.67	1.025
8..........	July 21	July 19	3	2.94	4.03	2.90	9.87	....	....	63.83	1.031
9..........	July 25	July 20	2	2.64	4.42	1.84	8.90	....	....	60.20	1.035
10..........	July 26	July 25	1	3.07	5.07	2.01	10.15	....	....	62.95	[illegible]
11..........	Aug. 4	July 30	2	3.65	5.79	2.22	11.66	5.30	....	61.45	[illegible]
12..........	Aug. 8	Aug. 5	1	3.22	3.85	2.89	9.96	3.66	—2.26	64.33	[illegible]
13..........	Aug. 15	Aug. 14	2	2.96	5.03	1.53	9.52	3.18	.54	57.23	[illegible]
14..........	Aug. 23	Aug. 17	1	2.19	9.27	2.03	13.49	7.92	5.05	53.99	[illegible]
15..........	Aug. 27	Aug. 19	1	2.40	11.02	4.14	17.56	10.98	4.48	58.38	[illegible]
16..........	Aug. 31	Aug. 26	1	2.74	4.72	3.11	10.57	....	—1.13	54.71	[illegible]
17..........	Sept. 4	Aug. 30	2	2.66	13.20	2.07	17.93	10.84	8.47	56.06	1.047
18..........	Sept. 10	Sept. 6	1	2.50	7.58	1.05	11.13	....	4.03	53.63	1.047

EGYPTIAN SUGAR CORN.

Analyses made after the ears of corn had been plucked.

Number of days after stripping.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	
7	Aug. 18	Aug. 13	2	3.11	7.53	2.15	12.79	7.54	2.27	60.38	1.051
14	Aug. 23	Aug. 18	2	3.13	7.68	2.18	12.99	7.31	2.37	59.61	1.049
21	Aug. 31	Aug. 23	5	1.99	10.99	1.61	14.59	9.97	7.39	59.19	1.058
28	Sept. 6	Aug. 30	4	3.52	10.52	2.34	16.38	10.98	4.66	51.65	1.064

LINDSAY'S HORSE TOOTH.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	
Before 1....	June 27	June 16	4	1.38	.30	1.54	3.22	....	....	68.95	1.016
1	July 16	June 20	1	2.66	.92	2.42	6.00	....	....	65.62	1.024
2	July 16	June 27	1	3.85	.76	2.37	6.98	....	....	65.67	1.023
3	July 14	July 5	1	2.39	.58	2.71	5.68	....	....	67.61	1.020
4	July 16	July 17	1	3.28	2.05	2.34	7.67	....	....	57.50	1.029
5	July 17	July 15	1	2.03	.47	2.46	4.96	....	....	68.00	1.018
6	July 18	July 18	1	2.70	.90	1.86	5.46	....	....	74.29	1.025
7	July 21	July 19	2	2.64	.77	2.90	6.31	....	....	66.55	1.026
8	July 21	July 20	1	2.36	2.08	3.03	7.47	....	—3.31	68.56	1.024
9	July 25	July 25	2	2.88	6.97	2.39	12.24	....	1.75	65.39	1.030
10	Aug. 1	July 30	1	2.51	7.85	3.44	13.80	7.44	1.90	58.04	1.050
11	Aug. 8	Aug. 5	2	2.85	5.34	2.66	10.85	4.91	— .17	60.71	1.040
12	Aug. 8	Aug. 8	1	2.70	4.36	3.51	10.57	4.24	—1.85	62.29	1.040
13	Aug. 16	Aug. 15	2	2.88	7.06	1.97	11.41	5.26	2.61	60.92	1.043
14	Aug. 23	Aug. 19	1	3.02	6.13	1.59	10.74	5.90	1.51	54.56	1.042
15	Aug. 27	Aug. 23	1	2.92	4.81	3.46	11.19	4.61	—1.57	60.50	1.041
16	Aug. 31	Aug. 27	1	3.09	7.19	2.67	12.95	7.04	1.48	59.09	1.050
17	Sept. 4	Aug. 30	2	1.15	7.80	2.86	11.81	9.53	3.79	60.46	1.044
18	Sept. 10	Sept. 6	1	1.60	11.57	2.56	15.73	10.49	7.41	50.91	1.061

BLOUNT'S PROLIFIC.

Before 1....	July 7	July 5	1	1.75	.58	2.58	4.81	....	....	67.21	1.017
1	July 13	July 7	1	1.48	.25	3.18	4.91	....	....	56.37	1.018
2	July 16	July 8	1	2.79	.16	4.55	7.50	....	....	68.09	1.020
3	July 14	July 11	1	2.26	1.08	2.57	5.91	....	....	58.75	1.023
4	July 21	July 15	2	2.91	1.27	2.82	7.00	....	....	62.15	1.024
5	July 21	July 18	1	2.50	1.73	2.99	7.22	....	....	63.80	1.024
6	July 21	July 19	1	3.82	2.46	2.27	8.55	....	....	67.90	1.029
7	July 21	July 20	1	2.61	1.96	3.65	8.22	....	....	64.84	1.027
8	July 25	July 25	1	1.59	2.93	2.47	6.99	....	....	65.37	1.029
9	July 26	July 28	1	2.55	4.87	2.50	9.92	....	— .18	59.85	1.037
10	Aug. 1	July 30	2	3.38	5.88	2.40	11.66	5.11	.10	55.78	1.043
11	Aug. 7	Aug. 5	2	2.31	4.95	1.98	9.24	4.44	.66	50.40	1.036
12	Aug. 16	Aug. 8	2	2.13	3.98	3.17	9.28	3.73	—1.32	51.20	1.035
13	Aug. 23	Aug. 15	1	1.63	7.91	2.38	11.92	4.87	3.90	51.84	1.048
14	Aug. 27	Aug. 17	1	1.90	7.16	4.33	13.39	6.97	.93	57.47	1.045
15	Aug. 31	Aug. 19	1	.69	1.91	4.06	6.66	....	—2.84	52.52	1.028
16	Sept. 2	Sept. 1	1	.70	2.35	3.66	6.71	....	—1.95	42.62	1.027
17	Sept. 7	Sept. 6	1	1.36	8.40	2.89	12.65	6.06	4.15	55.22	1.051
18	Sept. 10	Sept. 8	1	1.92	6.95	3.13	12.00	7.15	1.90	49.67	1.041

IMPROVED PROLIFIC BREAD.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	
1	July 10	July 12	2	1.91	.23	2.23	4.37	....	....	65.90	1.016
2	July 15	July 15	1	1.83	.42	3.14	5.39	....	....	62.34	1.020
3	July 18	July 16	1	2.44	.90	2.03	5.37	....	....	70.06	1.024
4	July 21	July 18	1	2.86	1.61	2.61	7.08	....	....	63.35	1.024
5	July 23	July 19	2	2.96	1.43	2.28	6.67	....	....	64.04	1.026
6	July 26	July 20	1	3.87	1.77	2.87	8.51	1.47	....	61.63	1.033
7	July 26	July 25	1	2.44	2.31	2.68	7.43	2.16	....	61.39	1.029
8	Aug. 1	July 28	2	2.53	4.75	2.81	10.09	4.20	—.59	65.74	1.038
9	Aug. 9	July 30	1	2.68	7.58	1.65	11.91	7.02	3.25	57.89	1.049
10	Aug. 23	Aug. 3	1	3.76	5.20	2.52	11.48	7.01	—1.08	52.56	1.045
11	Aug. 23	Aug. 5	1	1.33	4.01	5.11	10.45	5.10	—2.43	61.60	1.043
12	Aug. 16	Aug. 11	2	2.65	6.20	.32	9.17	5.90	3.23	58.04	1.043
13	Aug. 23	Aug. 15	2	2.35	5.22	2.42	9.99	6.41	.45	62.36	1.046
14	Aug. 27	Aug. 17	2	2.35	7.36	2.48	12.19	6.65	2.53	60.30	1.044
15	Aug. 31	Aug. 19	1	2.05	4.79	1.95	8.79	....	.79	40.06	1.035
16	Sept. 2	Aug. 28	1	2.05	4.29	2.83	9.16	3.95	—.59	51.49	1.035
17	Sept. 7	Aug. 30	1	1.92	6.50	2.00	10.42	....	2.58	63.18	1.041
18	Sept. 10	Sept. 5	1	1.61	3.31	2.54	7.46	2.08	—.84	54.95	1.031

BROAD WHITE FLAT DENT.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 10	July 12	2	2.49	.26	1.72	4.47	....	....	65.50	1.019
2	July 15	July 15	1	2.50	.59	2.18	5.27	....	....	66.79	1.022
3	July 21	July 16	1	3.29	1.16	2.67	7.12	....	....	58.69	1.025
4	July 21	July 18	1	3.11	1.04	2.97	7.12	....	....	61.55	1.035
5	July 23	July 19	2	3.33	1.37	2.74	7.44	....	....	70.40	1.027
6	July 26	July 20	1	3.59	1.47	2.81	7.87	1.27	....	59.61	1.029
7	July 26	July 25	1	3.74	3.12	2.02	8.88	2.83	....	66.93	1.036
8	Aug. 1	July 30	1	3.66	4.29	2.62	10.57	3.75	—1.99	59.46	1.040
9	Aug. 9	Aug. 3	1	2.25	9.97	1.33	13.55	8.14	6.39	59.97	1.055
10	Aug. 16	Aug. 5	2	2.63	4.65	3.09	10.37	4.63	—1.07	54.25	1.040
11	Aug. 23	Aug. 11	1	3.53	4.30	3.04	10.87	4.36	—2.27	60.39	1.044
12	Aug. 29	Aug. 15	2	2.92	7.64	3.86	14.42	6.13	.86	62.72	1.047
13	Sept. 2	Aug. 17	1	2.84	9.97	2.26	15.07	8.73	4.87	51.40	1.055
14	Sept. 7	Aug. 19	1	2.25	12.55	2.50	17.30	11.74	7.80	51.47	1.069
15	Sept. 10	Aug. 25	1	1.15	3.53	2.89	7.57	3.24	—.51	47.03	1.030

LONG NARROW WHITE DENT.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 7	July 15	1	2.21	.23	1.71	4.14	....	....	68.84	1.019
2	July 15	July 16	1	2.41	1.83	3.96	8.20	....	....	60.27	1.024
3	July 21	July 18	1	3.54	1.43	2.56	7.53	....	....	65.97	1.029
4	July 21	July 19	1	3.27	1.04	3.29	7.60	....	....	65.87	1.026
5	July 21	July 20	1	3.48	1.60	2.34	7.42	....	....	60.27	1.023
6	July 26	July 25	1	3.15	3.56	2.10	8.81	2.89	....	60.96	1.032
7	July 26	July 28	1	3.69	3.05	2.16	8.90	....	....	56.83	1.033
8	Aug. 1	July 30	2	3.36	5.57	3.11	12.04	5.36	....	59.77	1.045
9	Aug. 9	Aug. 3	1	4.50	4.40	1.47	10.37	3.65	—1.57	56.96	1.041
10	Aug. 12	Aug. 5	1	4.41	8.32	2.27	15.00	8.03	1.64	58.70	1.053
11	Aug. 18	Aug. 11	1	2.58	6.90	2.48	11.96	7.03	1.84	62.77	1.049
12	Aug. 23	Aug. 15	1	1.97	10.67	2.32	14.96	10.49	6.88	62.24	1.059
13	Aug. 25	Aug. 17	3	2.42	10.23	2.04	14.69	11.57	5.77	52.81	1.057
14	Aug. 27	Aug. 19	1	3.16	7.59	2.75	13.50	7.28	1.68	57.73	1.048
15	Aug. 31	Aug. 23	2	1.58	5.31	3.80	10.69	5.26	—.07	52.55	1.042
16	Sept. 2	Aug. 27	2	3.25	9.51	3.24	17.00	9.39	3.03	45.95	1.056
17	Sept. 7	Aug. 30	1	1.84	12.11	2.52	16.47	....	7.75	56.00	1.065
18	Sept. 10	Sept. 2	2	2.53	10.44	2.18	15.15	10.25	5.73	55.47	1.066

CHESTER COUNTY MAMMOTH.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
1	July 10	July 6	2	3.75	.49	2.19	6.43	....	....	59.65	1.021
2	July 15	July 9	1	2.97	.72	2.91	6.60	....	....	71.76	1.022
3	July 15	July 11	1	3.85	.16	3.81	7.82	....	....	60.84	1.022
4	July 15	July 12	1	3.81	2.00	3.73	9.54	....	....	56.24	1.032
5	July 15	July 13	1	2.74	1.41	4.68	8.83	....	....	57.67	1.025
6	July 18	July 15	1	3.17	3.22	2.32	8.71	....	....	61.68	1.038
7	July 21	July 18	1	3.74	2.13	3.33	9.20	....	....	55.96	1.034
8	July 26	July 19	3	2.53	5.39	2.86	10.78	5.71	....	58.01	1.038
9	July 26	July 20	1	2.64	7.76	1.65	12.05	....	3.47	56.04	1.050
10	July 26	July 25	1	2.92	8.24	1.99	13.15	....	3.33	59.55	1.040
11	Aug. 9	July 28	1	3.24	6.16	.73	10.13	5.25	2.19	54.62	1.041
12	Aug. 12	July 30	1	2.40	5.82	2.92	11.14	5.54	.50	57.01	1.041
13	Aug. 18	Aug. 3	1	3.36	5.12	1.75	10.23	4.89	.01	52.41	1.039
14	Aug. 24	Aug. 5	1	1.25	2.47	3.08	6.80	2.26	—1.86	55.81	1.029
15	Aug. 26	Aug. 11	2	1.80	8.32	3.17	13.29	12.37	3.35	55.31	1.050
16	Aug 31	Aug. 15	1	1.32	3.78	4.16	9.26	....	—1.70	41.06	1.036
17	Sept. 4	Aug. 19	2	1.47	8.93	2.86	13.26	....	4.60	52.59	1.051
18	Sept. 10	Aug. 22	1	1.44	5.94	2.43	9.81	5.20	2.07	46.77	1.039

EIGHTEEN-ROWED YELLOW DENT.

Stage.	Average date of estimation.	Observed date of reaching stage.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Per cent. of sucrose polarization.	Available sucrose.	Average juice.	Average specific gravity.
1	July 7	July 11	1	3.58	.85	1.79	5.72	....	....	65.36	1.022
2	July 15	July 15	1	3.64	.48	3.21	7.33	....	....	62.38	1.023
3	July 15	July 16	1	2.86	.65	4.89	8.40	....	....	62.32	1.023
4	July 18	July 18	1	2.49	1.89	5.34	9.72	....	....	63.47	1.028
5	July 21	July 19	1	3.86	1.57	2.83	8.26	....	....	62.84	1.028
6	July 21	July 20	1	4.21	2.07	2.98	9.26	....	....	60.17	1.031
7	July 21	July 25	1	3.95	2.23	2.67	8.85	....	....	60.09	1.028
8	July 26	Aug. 5	1	3.96	3.36	1.40	8.72	....	....	61.03	1.032
9	Aug. 1	Aug. 11	1	3.65	5.17	2.92	11.74	....	—1.40	60.02	1.043
10	Aug. 9	Aug. 15	1	3.05	6.87	1.88	11.80	6.40	2.44	54.82	1.044
11	Aug. 12	Aug. 19	1	3.20	8.24	2.81	14.25	7.58	2.23	54.90	1.052
12	Aug. 18	Aug. 20	1	3.35	4.15	2.05	9.55	7.48?	—1.25	55.40	1.036
13	Aug. 25	Aug. 23	4	1.47	11.46	2.14	15.07	9.77	7.85	54.12	1.055
14	Aug. 27	Aug. 25	1	2.80	8.13	3.39	14.32	8.34	1.94	59.38	1.051
15	Aug. 31	Aug. 28	1	3.22	6.18	2.56	11.96	....	.40	49.64	1.045
16	Sept. 3	Aug. 30	1	2.11	11.39	5.80	19.30	11.44	3.48	50.00	1.062
17	Sept. 7	Sept. 3	1	1.20	4.35	2.12	7.67	....	1.08	37.94	1.030
18	Sept. 10	Sept. 6	2	1.57	11.65	2.64	15.86	10.85	7.44	63.53	1.057

AVERAGE OF ALL VARIETIES IN DIFFERENT STAGES.

BEFORE FIRST STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Early Amber	2	3.46	.78	3.82	112.24	2.032	....	2.61
White Liberian..................	1	2.88	4.31	....	68.00	1.020	....	....
White Mammoth	1	1.11	.26	3.17	65.67	1.012	....	....
Link's Hybrid..................	1	1.63	.70	2.30	67.20	1.015	....	....
Do..................	1	1.47	.93	3.10	70.69	1.017	....	....
Sugar Cane	1	1.41	1.21	2.79	68.06	1.015	....	....
Early Orange	1	2.46	.46	3.03	64.56	1.017	....	....
Orange Cane..................	1	2.94	....	2.01	66.93	1.020	....	....
Gray Top..................	1	1.36	.49	2.83	66.67	1.015	....	....
Liberian	1	1.92	.28	2.97	73.08	1.014	....	....
Honduras	3	12.06	3.36	6.87	188.28	3.078	....	....
White Imphee..................	1	2.38	.39	2.37	63.40	1.021	....	....
Goose Neck..................	1	1.91	.93	3.12	69.35	1.014	....	....
Holcus Sorghum	2	2.16	1.82	4.92	126.28	2.034	....	....
Holcus Cernus, White..................	1	1.07	.37	2.44	59.91	1.016	....	....
Total	16	36.99	14.19	38.38	1,044.22	16.290	....	....
Average	......	2.31	.89	2.40	65.30	1.018	....	....

FIRST STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct		Pr. ct.	
Early Amber	1	3.15	1.15	2.65	53.69	1.028	......	......
Early Golden	1	3.11	2.01	.90	66.99	1.026	......	......
White Liberian	1	2.96	1.20	.69	64.29	1.024	......	......
Do	1	4.46	.46	1.40	72.93	1.027	......	......
Black Top	1	2.06	2.72	3.61	67.85	1.030	......	......
Black Tail	1	1.81	4.69	2.47	61.06	1.036	.41	......
African	1	1.99	2.45	2.91	68.09	1.027	......	......
White Mammoth	1	1.81	.49	1.67	67.58	1.020	......	......
Oomseeana	1	2.01	2.33	4.58	70.43	1.027	......	......
Regular Sorgho	1	3.71	......	3.60	71.56	1.025	......	......
Link's Hybrid	1	2.16	2.43	2.72	67.18	1.025	......	......
Do	1	2.19	2.22	2.51	72.45	1.025	......	......
Sugar Cane	1	2.07	2.63	2.70	68.41	1.026	......	......
Goose Neck	1	3.62	.14	2.19	73.00	1.024	......	......
Bear Tail	1	2.94	.27	1.65	67.91	1.023	......	......
Iowa Red Top	1	2.99	.48	4.12	68.27	1.020	......	......
New Variety	1	3.12	.74	2.21	68.48	1.020	......	......
Early Orange	1	2.45	.81	1.87	67.81	1.022	......	......
Do	1	4.59	.76	1.01	66.38	1.029	......	......
Orange Cane	1	4.91	.37	2.13	65.06	1.032	......	......
Neeazana	1	4.24	......	3.11	62.21	1.026	......	......
Wolf Tail	1	1.96	1.04	3.87	58.70	1.019	......	......
Gray Top	1	3.57	.05	2.40	61.46	1.021	......	......
Liberian	1	4.71	2.41	2.20	64.43	1.034	......	......
Mastodon	1	1.84	.32	2.17	65.67	1.016	......	......
Honduras	1	5.03	1.51	3.60	69.97	1.035	......	......
Sugar Cane	1	4.31	2.41	3.64	71.12	1.038	......	......
Hybrid No. 4	2	5.88	.64	4.54	136.26	2.036	......	......
White Imphee	1	3.45	1.06	2.31	60.81	1.025	......	......
Goose Neck	1	2.86	.24	2.88	62.62	1.021	......	......
White African	1	2.39	.41	2.26	65.13	1.017	......	......
West India Sugar Cane	2	11.96	3.74	3.54	135.44	2.072	......	2.56
Sugar Cane	1	3.19	.28	1.78	69.72	1.019	......	......
New Variety of Liberian and Oomseeana	1	3.78	.78	2.81	67.54	1.024	......	......
Minnesota Early Amber	1	3.15	.32	1.85	68.90	1.018	......	......
Holcus Saccharatus	1	1.03	.56	2.79	64.12	1.016	......	......
Holcus Sorghum	1	1.04	1.18	3.17	56.95	1.020	......	......
Holcus Cernua, White	1	.85	2.05	2.51	50.56	1.027	......	......
Honey Cane	1	1.78	......	2.45	71.39	1.016	......	......
Total	38	123.21	45.65	92.00	2,551.91	38.953	......	......
Average	......	3.24	1.20	2.42	67.13	1.025	.00	......

SECOND STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	2.92	1.52	1.45	63.29	1.026	......	......
Early Golden	1	3.10	1.36	2.40	69.68	1.027	......	......
White Liberian	1	3.08	1.76	2.21	72.31	1.027	......	......
Do	2	6.60	1.40	3.98	138.96	2.054	......	......
Black Top	1	2.00	1.13	2.65	66.60	1.020	......	......
Black Tail	1	1.56	4.95	1.85	59.16	1.036	1.54	......
African	1	1.84	1.28	1.64	61.42	1.018	......	......
White Mammoth	2	6.04	7.46	3.72	131.24	2.065	......	6.54
Oomseeana	1	1.90	1.55	1.79	64.71	1.021	......	......
Regular Sorgho	1	2.07	.53	2.78	64.03	1.020	......	......
Link's Hybrid	1	2.21	3.42	1.53	67.48	1.033	......	......
Do	1	2.13	3.04	1.18	66.00	1.030	......	......
Sugar Cane	1	2.11	3.24	1.19	69.48	1.031	......	......
Goose Neck	1	2.45	.46	2.21	60.79	1.019	......	......
Bear Tail	1	3.12	......	2.57	66.11	1.019	......	......
Iowa Red Top	1	3.19	.58	1.81	68.88	1.020	......	......
New Variety	1	3.64	.39	4.31	70.26	1.025	......	......
Early Orange	1	3.65	1.85	2.44	68.89	1.026	......	......
Do	1	5.25	1.76	3.27	66.78	1.035	......	......
Orange Cane	1	4.92	.05	2.59	68.36	1.029	......	......
Neeazana	2	8.14	.78	6.18	132.86	2.050	......	......
Wolf Tail	1	2.64	3.93	2.34	67.22	1.032	......	......
Gray Top	1	2.57	3.97	1.88	65.64	1.033	......	......
Liberian	1	5.36	3.08	1.81	64.33	1.039	......	2.78
Mastodon	1	3.73	1.15	3.14	68.56	1.028	......	......

SECOND STAGE—Continued.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Honduras	1	5.04	5.04	1.78	70.99	1.045	....	4.18
Sugar Cane	1	3.48	.27	4.99	73.52	1.023	....	....
Hybrid No. 4	1	3.06	.87	2.85	71.46	1.019	....	....
White Imphee	1	4.12	.90	3.18	67.33	1.030	....	....
Goose Neck	1	2.98	.31	1.87	65.14	1.017	....	....
White African	1	3.66	.98	5.02	71.62	1.024	....	....
West India Sugar Cane	2	10.80	6.28	5.50	126.50	2.080	....	5.62
Sugar Cane	1	3.73	.30	1.87	67.46	1.024	....	....
New Variety of Liberian and Oomseeana	1	3.44	....	2.44	66.47	1.020	....	....
Minnesota Early Amber	1	2.75	5.84	2.69	66.51	1.041	.89	....
Holcus Saccharatus	1	2.88	....	2.95	72.98	1.020	....	....
Holcus Sorghum	1	.67	.38	2.97	52.09	1.018	....	....
Holcus Cernus, White	2	2.36	1.06	6.02	108.90	2.036	....	....
Honey Cane	1	4.61	2.53	1.16	68.21	1.030	....	1.78
Total	40	133.89	73.46	96.22	2,679.24	41.117	....	20.98
Average	......	3.35	1.84	2.41	69.48	1.029	.00	2.98

THIRD STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	2.20	.58	4.10	70.85	1.021	....	....
Early Golden	1	3.17	1.58	3.16	71.33	1.023	....	....
White Liberian	2	6.20	1.78	6.00	143.24	2.048	....	....
Do	1	2.80	1.55	3.25	70.41	1.025	....	....
Black Top	2	4.84	4.38	8.10	141.00	2.052	....	....
Black Tail	1	1.87	5.66	1.19	58.89	1.039	2.60	....
African	2	3.82	4.62	8.46	134.74	2.048	....	....
White Mammoth	2	6.90	6.04	7.84	135.30	2.068	....	5.80
Oomseeana	2	4.64	1.66	6.18	123.20	2.046	....	....
Regular Sorgho	2	5.06	3.28	2.52	137.90	2.044	....	....
Link's Hybrid	1	1.88	3.96	2.40	65.11	1.031	....	....
Do	1	2.39	4.34	3.14	68.52	1.033	....	....
Sugar Cane	1	2.98	2.94	2.40	68.08	1.027	....	....
Goose Neck	1	2.79	.65	5.46	68.96	1.022	....	....
Bear Tail	3	7.89	1.26	9.08	205.11	3.066	....	....
Iowa Red Top	2	5.98	1.94	9.04	134.14	2.040	....	....
New Variety	2	6.16	2.10	6.12	145.16	2.046	....	....
Early Orange	1	4.40	2.11	1.32	69.15	1.035	....	....
Do	2	12.00	5.54	4.00	137.78	2.080	....	4.36
Orange Cane	1	4.96	1.12	.84	68.51	1.032	....	....
Neeazana	1	4.55	1.66	2.57	66.67	1.030	....	....
Wolf Tail	1	3.00	5.62	2.21	69.23	1.043	.41	5.84
Gray Top	1	4.12	2.73	2.04	66.67	1.034	....	2.81
Liberian	2	11.20	8.12	4.32	133.84	2.088	....	7.54
Mastodon	2	6.80	7.58	4.24	132.76	2.070	....	5.84
Honduras	1	6.25	3.88	1.74	68.39	1.044	....	3.11
Sugar Cane	1	3.56	.67	3.15	69.16	1.028	....	....
Hybrid No. 4	1	3.37	.05	2.31	71.25	1.019	....	....
White Imphee	2	8.42	4.84	6.42	135.08	2.068	....	....
Goose Neck	1	2.88	....	3.28	65.29	1.020	....	....
White African	1	2.51	.35	5.28	69.83	1.019	....	....
West India Sugar Cane	2	10.48	7.90	6.52	128.18	2.090	....	6.46
Sugar Cane	1	3.21	.24	2.96	70.18	1.021	....	....
New Variety of Liberian and Oomseeana	1	3.06	.46	3.14	65.00	1.021	....	....
Minnesota Early Amber	2	6.50	1.38	4.76	130.58	2.046	....	....
Holcus Saccharatus	1	1.92	1.76	3.84	66.97	1.025	....	....
Holcus Sorghum	1	1.04	.46	3.81	50.67	1.020	....	....
Holcus Cernus, White	2	2.78	4.74	4.36	107.46	2.052	....	....
Honey Cane	1	4.61	2.38	1.12	71.44	1.029	....	1.81
Total	52	177.45	104.96	150.56	3,536.88	53.491	....	48.07
Average	......	3.41	2.02	2.90	68.02	1.029	.00	3.08

FOURTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Early Amber	2	5.56	1.63	7.00	128.76	2.024	....	....
Early Golden	2	4.92	3.08	4.00	134.06	2.042	....	....
White Liberian	2	5.48	2.40	4.10	130.10	2.050	....	....
Do	1	3.18	1.25	9.82	74.14	1.021	....	....
Black Top	1	3.52	1.47	4.10	70.49	1.028	....	....
Black Tail	3	4.65	18.72	10.80	175.59	3.132	3.27	15.93
African	1	3.10	1.20	3.38	65.09	1.028	....	....
White Mammoth	1	2.71	6.74	3.60	65.05	1.046	.84	6.96
Oomseeana	1	3.48	1.36	2.91	65.94	1.027	....	....
Regular Sorgho	1	1.86	2.43	2.78	71.57	1.026	....	....
Link's Hybrid	3	6.99	16.56	13.86	206.25	3.132	....	21.09
Do	1	2.72	7.46	1.86	65.19	1.047	2.84	7.17
Sugar Cane	1	2.63	4.39	3.97	71.68	1.037	....	....
Goose Neck	1	3.15	.55	2.88	71.66	1.022	....	....
Bear Tail	1	3.72	.69	3.56	60.43	1.023	....	....
Iowa Red Top	1	3.05	1.11	3.05	71.17	1.025	....	....
New Variety	1	3.20	1.00	3.31	73.03	1.025	....	....
Early Orange	1	5.18	2.05	2.52	70.02	1.035	....	....
Do	1	6.21	4.55	2.29	67.89	1.050	....	3.95
Orange Cane	1	5.26	1.10	2.64	71.79	1.033	....	....
Neeazana	1	4.97	1.15	3.71	70.43	1.036	....	....
Wolf Tail	1	2.09	5.96	2.62	67.56	1.043	.65	5.92
Gray Top	2	6.68	10.82	4.90	139.80	2.088	....	10.12
Liberian	1	6.28	3.27	2.85	68.43	1.046	....	....
Mastodon	2	8.62	5.94	6.08	137.98	2.070	....	....
Honduras	1	5.21	4.19	2.58	63.78	1.043	....	3.72
Sugar Cane	2	6.80	2.12	8.00	141.58	2.050	....	....
Hybrid No. 4	1	3.49	.11	5.96	73.89	1.020	....	....
White Imphee	1	4.22	3.55	2.01	71.07	1.037	....	....
Goose Neck	1	4.78	1.65	1.70	69.29	1.032	....	....
White African	1	2.99	.62	2.00	67.50	1.024	....	....
West India Sugar Cane	1	5.06	5.27	....	69.75	1.050	....	....
Sugar Cane	1	3.01	....	2.23	68.01	1.020	....	....
New Variety of Liberian and Oomseeana	1	4.02	.23	2.57	64.25	1.026	....	....
Minnesota Early Amber	1	3.17	.81	2.21	71.71	1.024	....	....
Holcus Saccharatus	1	1.27	2.81	4.01	56.27	1.032	....	....
Holcus Sorghum	1	3.55	....	1.35	63.66	1.020	....	....
Holcus Cernua, White	1	.98	2.72	3.19	54.03	1.080	....	....
Honey Cane	1	5.19	2.64	2.50	72.28	1.035	....	1.85
Total	46	157.79	128.06	146.43	3,136.21	47.477	....	77.31
Average		3.43	2.78	3.18	68.18	1.032	.00	5.52

FIFTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	2.61	.99	2.80	63.80	1.023	....	....
Early Golden	2	5.24	3.38	8.20	137.70	2.048	....	....
White Liberian	2	4.96	3.58	9.06	130.68	2.060	....	....
Do	1	3.25	1.96	4.15	72.39	1.028	....	....
Black Top	1	3.30	2.34	3.23	71.89	1.032	....	....
Black Tail	2	4.58	11.58	8.56	120.00	2.086	....	8.72
African	1	1.79	8.25	2.77	69.07	1.030	....	....
White Mammoth	1	3.28	7.71	1.87	69.17	1.050	2.56	7.15
Oomseeana	1	1.88	2.86	5.72	68.15	1.029	....	....
Regular Sorgho	1	2.92	1.20	1.74	69.41	1.026	....	....
Link's Hybrid	4	10.92	18.60	8.84	278.88	4.148	....	17.04
Do	2	5.32	14.94	3.24	135.28	2.096	6.36	13.18
Sugar Cane	3	6.98	18.42	7.47	206.71	3.126	4.02	17.82
Goose Neck	1	3.25	.51	1.81	72.00	1.023	....	....
Bear Tail	1	3.65	.87	5.22	70.11	1.024	....	....
Iowa Red Top	1	3.51	.87	3.41	69.63	1.026	....	....
New Variety	1	3.33	.41	4.73	70.95	1.026	....	....
Early Orange	1	5.83	3.24	1.20	71.01	1.041	....	2.17
Do	2	11.80	7.88	3.74	136.18	2.090	....	....
Orange Cane	1	5.51	1.26	2.19	71.39	1.032	....	....
Neeazana	1	5.48	1.85	.83	69.19	1.036	....	....
Wolf Tail	2	7.02	14.26	5.66	135.42	2.103	1.58	13.42
Gray Top	2	6.62	12.58	6.76	135.62	2.116	....	5.881
Liberian	1	7.26	4.53	2.31	59.93	1.050	....	2.85
Mastodon	1	4.62	4.75	1.26	69.55	1.040	....	2.89

FIFTH STAGE—Continued.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Honduras	1	6.12	5.89	1.93	69.21	1.055	....	5.24
Sugar Cane	2	6.90	3.24	7.40	131.10	2.056	....	....
Hybrid No. 4	1	4.74	.23	3.24	71.48	1.028	....	....
White Imphee	2	7.94	11.28	3.84	137.12	2.086	....	9.82
Goose Neck	2	10.62	7.40	2.94	129.20	2.078	....	5.52
White African	1	3.35	1.54	3.53	68.00	1.028	....	....
West India Sugar Cane	1	5.69	6.91	2.58	65.02	1.054	....	6.60
Sugar Cane	1	4.23	....	2.49	68.79	1.026	....	....
New Variety, of Liberian and Oomseeana	1	4.71	.48	2.48	66.58	1.029	....	....
Minnesota Early Amber	1	3.22	.32	2.08	70.82	1.021	....	....
Holcus Saccharatus	1	2.10	3.84	3.21	48.17	1.038	....	....
Holcus Sorghum	1	1.03	1.63	3.20	56.29	1.025	....	....
Holcus Cernua, White	1	1.65	7.67	4.26	44.36	1.056	1.76	....
Honey Cane	1	5.80	2.63	2.30	71.70	1.039	....	5.46?
Total	51	188.27	183.75	141.56	3,471.75	52.880	....	121.42
Average		3.69	3.60	2.78	68.07	1.035	.00	5.28

SIXTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	3.17	3.10	2.42	68.23	1.047	....	....
Early Golden	1	2.96	4.04	3.67	68.01	1.036	....	....
White Liberian	1	3.21	2.85	2.66	72.78	1.032	....	....
Do	1	3.15	4.09	.99	69.23	1.038	....	....
Black Top	1	3.81	2.45	3.45	71.48	1.033	....	....
Black Tall	1	1.19	7.93	4.50	58.08	1.050	2.24	7.75
African	1	1.99	4.41	1.04	68.69	1.035	1.88	....
White Mammoth	1	3.52	6.13	2.06	60.35	1.046	.55	6.02
Oomseeana	1	3.47	1.23	2.60	67.57	1.026	....	....
Regular Sorgho	1	3.53	2.15	2.69	67.77	1.027	....	....
Link's Hybrid	2	5.48	13.56	6.24	137.16	2.090	1.84	5.86
Do	2	4.62	18.56	5.60	126.98	2.114	3.34	15.92
Sugar Cane	3	7.71	20.46	8.49	209.46	3.144	4.26	18.42
Goose Neck	1	4.04	1.91	2.28	72.34	1.033	....	....
Bear Tail	1	3.89	.93	2.29	67.49	1.028	....	....
Iowa Red Top	1	4.11	.92	2.52	68.39	1.027	....	....
New Variety	1	4.32	.81	2.87	64.20	1.026	....	....
Early Orange	2	9.94	14.70	5.28	133.04	2.116	....	10.06
Do	2	12.24	10.94	7.56	133.80	2.110	....	6.58
Orange Cane	1	5.06	3.67	3.57	70.95	1.040	....	....
Neeazana	1	5.84	2.78	2.91	68.10	1.040	....	....
Wolf Tail	1	2.08	7.93	5.75	68.67	1.053	....	7.75
Liberian	1	6.63	3.32	2.33	63.05	1.064	....	7.20
Gray Top	1	3.88	4.83	3.55	53.23	1.044	....	4.65
Mastodon	1	4.21	8.07	1.96	68.43	1.053	1.90	7.75
Honduras	1	6.04	5.96	1.75	71.41	1.055	....	5.68
Sugar Cane	1	4.36	.73	2.34	65.90	1.029	....	....
Hybrid No. 4	1	4.67	.13	3.55	70.01	1.029	....	....
White Imphee	1	4.68	7.41	2.42	68.36	1.054	.81	7.45
Goose Neck	1	4.89	4.99	2.54	58.45	1.046	....	4.28
White African	1	3.70	.81	2.43	67.66	1.023	....	....
West India Sugar Cane	1	4.00	11.18	1.27	61.05	1.070	5.91	10.69
Sugar Cane	1	4.19	.87	3.71	67.90	1.021	....	....
New Variety, of Liberian and Oomseeana	1	4.77	.18	1.99	67.86	1.030	....	....
Minnesota Early Amber	1	3.45	1.99	1.09	66.72	1.026	....	....
Holcus Saccharatus	1	2.59	2.82	4.47	41.86	1.037	....	3.02
Holcus Sorghum	2	1.88	2.92	3.82	94.72	2.042	....	....
Holcus Cernua, White	1	1.64	6.14	4.44	41.84	1.047	.06	5.80
Honey Cane	1	4.17	7.30	1.19	71.23	1.050	1.94	6.26
Total	42	162.96	197.81	118.06	2,823.08	43.785	....	132.32
Average	......	3.88	4.71	2.81	67.21	1.042	.00	6.01

SEVENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Early Amber	1	3.54	4.83	3.63	65.79	1.041	....	....
Early Golden	1	3.00	5.25	1.17	66.39	1.040	1.08	....
White Liberian	1	3.03	5.21	1.35	72.07	1.042	.83	....
Do	1	2.84	6.94	1.25	60.83	1.047	2.85	....
Black Top	1	4.53	3.41	.50	70.23	1.042	....	....
Black Tail	2	3.38	19.58	8.74	114.82	2.120	7.46	17.96
African	1	2.52	6.96	4.86	69.11	1.046	....	....
White Mammoth	1	2.17	9.55	2.74	66.47	1.054	4.64	8.93
Oomseeana	1	4.11	2.18	1.83	70.82	1.034	....	....
Regular Sorgho	1	1.55	5.74	3.22	56.34	1.046	.97	....
Link's Hybrid	2	4.02	21.64	6.46	128.48	2.120	11.16	20.73
Do	1	2.61	8.01	3.87	63.72	1.052	1.53	7.69
Sugar Cane	2	5.16	14.02	11.54	139.44	2.098	....	13.90
Goose Neck	1	4.23	2.29	.82	66.45	1.034	....	....
Bear Tail	1	3.30	2.12	2.13	74.02	1.029	....	....
Iowa Red Top	1	3.73	5.28	2.59	70.79	1.048	....	....
New Variety	1	3.63	4.92	....	68.51	1.042	....	....
Early Orange	1	5.64	5.23	4.76	68.09	1.052	....	5.21
Do	1	5.89	4.83	4.76	66.72	1.051	....	4.37
Orange Cane	1	5.54	6.33	1.90	68.31	1.053	....	5.86
Neeazana	1	5.58	3.76	2.71	69.27	1.041	....	....
Wolf Tail	1	2.82	9.62	4.33	66.00	1.061	2.48	9.92
Gray Top	1	4.80	6.22	1.58	66.16	1.049	.34	5.11
Liberian	1	4.37	10.93	3.00	56.36	1.071	3.56	10.73
Mastodon	1	6.01	4.41	1.96	69.07	1.049	....	3.74
Honduras	2	8.76	19.78	3.58	138.40	2.124	7.44	17.76
Sugar Cane	1	4.43	4.96	1.19	62.96	1.045	....	....
Hybrid No. 4	1	5.07	1.56	1.50	66.38	1.034	....	....
White Imphee	1	3.01	8.85	4.85	66.29	1.065	.99	....
Goose Neck	1	3.35	7.48	4.83	62.36	1.053	....	....
White African	2	7.92	.52	9.40	125.32	2.074	....	....
West India Sugar Cane	1	3.25	14.07	2.04	68.27	1.075	8.78	12.01
Sugar Cane	1	4.76	.71	2.77	72.29	1.031	....	....
New Variety, of Liberian and Oomseeana	1	4.89	1.67	3.68	76.81	1.035	....	....
Minnesota Early Amber	1	3.38	.39	4.56	72.77	1.034	....	....
Holcus Saccharatus	1	2.76	3.18	4.28	42.72	1.038	....	....
Holcus Sorghum	2	2.40	6.94	9.72	94.92	2.064	....	6.32
Holcus Cernua, White	1	1.85	5.96	4.51	48.30	1.047	....	1.94
Honey Cane	2	8.94	16.68	4.18	132.62	2.112	3.36	15.19
Total	42	155.26	255.47	124.37	2,848.22	44.039	....	159.71
Average	....	3.69	6.08	3.03	67.81	1.048	.00	7.96

EIGHTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	3.57	3.53	3.27	66.81	1.036	....	....
Early Golden	1	2.97	5.42	1.17	69.57	1.046	1.18	....
White Liberian	1	3.01	5.63	5.04	72.61	1.041	....	....
Do	1	2.98	7.15	3.38	71.83	1.036	.79	....
Black Top	1	2.45	6.41	3.20	65.45	1.044	.76	....
Black Tail	2	2.70	23.00	4.48	113.88	2.128	15.82	20.60
African	1	2.93	5.82	4.62	66.71	1.047	....	....
White Mammoth	1	2.41	12.07	1.32	70.35	1.066	8.34	10.96
Oomseeana	1	1.46	9.38	3.44	69.60	1.050	4.48	....
Regular Sorgho	1	2.96	3.42	3.35	71.19	1.034	....	....
Link's Hybrid	1	3.01	9.04	2.69	69.30	1.058	3.34	8.62
Do	1	2.70	11.25	1.55	67.50	1.064	7.00	10.60
Sugar Cane	1	2.24	9.11	4.27	67.85	1.056	2.60	9.29
Goose Neck	2	8.66	8.42	5.56	139.94	2.082	....	....
Bear Tail	1	3.83	3.34	.78	68.74	1.038	....	....
Iowa Red Top	2	5.86	13.56	6.64	141.40	2.092	1.06	....
New Variety	1	3.33	6.00	2.44	69.86	1.045	.22	....
Early Orange	1	5.44	10.69	1.67	62.72	1.072	3.58	13.35
Do	1	4.24	13.31	2.43	58.69	1.076	6.64	13.00
Orange Cane	1	4.88	7.85	2.20	68.94	1.058	.77	....
Neeazana	2	11.02	11.68	5.80	139.18	2.104	....	10.92
Wolf Tail	1	3.16	12.27	.98	65.77	1.066	8.13	10.78
Gray Top	1	3.90	9.18	1.68	64.46	1.060	3.60	7.77
Liberian	1	4.54	11.06	2.58	66.55	1.078	3.94	10.81
Mastodon	1	3.47	7.75	2.93	60.76	1.053	1.35	7.44

EIGHTH STAGE—Continued.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Honduras	1	5.86	8.30	1.29	66.70	1.061	1.15	7.98
Sugar Cane	1	4.90	3.74	3.32	71.38	1.045	....	....
Hybrid No. 4	2	10.94	4.02	6.32	132.72	2.076	....	....
White Imphee	2	6.64	25.80	5.40	122.82	2.142	13.76	24.30
Goose Neck	2	10.46	16.14	8.54	132.08	2.112	2.14	13.26
White African	1	3.85	4.29	1.96	67.85	1.039	....	....
West India Sugar Cane	1	3.34	14.86	2.42	53.10	1.083	9.09	14.41
Sugar Cane	1	4.62	4.76	....	64.53	1.037	....	....
New Variety, of Liberian and Oomseeana	2	10.28	8.86	7.60	132.40	2.086	....	....
Minnesota Early Amber	1	.96	6.86	1.31	72.00	1.040	4.59	....
Holcus Saccharatus	1	2.48	7.64	3.46	50.38	1.056	1.70	5.61
Holcus Sorghum	1	1.51	2.94	3.96	48.60	1.034	....	....
Holcus Cernua, White	1	.77	7.74	4.60	53.38	1.052	2.37	7.08
Honey Cane	2	6.98	12.58	7.88	132.26	2.098	....	12.86
Total	45	166.55	336.25	118.47	3,004.50	47.345	....	207.31
Average		3.70	7.47	2.63	66.76	1.052	1.14	9.42

NINTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	3	8.19	22.86	6.87	199.38	3.141	7.80	22.23
Early Golden	4	9.52	37.04	11.20	268.48	4.220	16.32	39.36
White Liberian	2	6.10	15.62	7.34	131.14	2.104	2.18	16.18
Do	1	2.78	9.05	4.96	68.21	1.054	1.31	....
Black Top	3	10.05	26.10	6.51	205.08	3.165	9.54	26.91
Black Tail	3	3.51	43.26	7.35	161.61	3.231	32.40	39.84
African	1	2.78	4.76	4.40	66.88	1.042	....	....
White Mammoth	2	4.78	20.18	7.62	132.04	2.140	7.78	23.58
Oomseeana	1	2.88	7.27	3.27	70.39	1.048	1.62	....
Regular Sorgho	1	3.14	5.47	2.96	70.24	1.045	....	....
Link's Hybrid	1	1.07	14.74	2.55	65.40	1.078	11.12	14.52
Do	1	1.98	12.22	2.54	63.39	1.069	7.70	12.12
Sugar Cane	1	1.28	13.64	2.12	75.78	1.071	10.24	12.98
Goose Neck	2	7.22	11.52	6.06	137.74	2.096	....	15.54
Bear Tail	3	11.61	15.84	9.03	204.75	3.138	....	18.30
Iowa Red Top	2	8.12	10.52	6.88	139.42	2.088	....	10.78
New Variety	2	6.90	13.82	6.06	139.32	2.084	.86	....
Early Orange	1	2.98	12.39	1.50	66.84	1.069	7.91	11.91
Do	1	3.91	11.62	1.86	66.42	1.069	5.85	11.21
Orange Cane	1	4.15	12.06	.95	65.27	1.069	6.96	11.22
Neeazana	2	12.38	11.22	4.52	141.98	2.108	....	10.72
Wolf Tail	2	4.78	25.68	4.84	132.90	2.142	16.06	17.40
Gray Top	2	7.30	22.70	2.72	153.80	2.130	12.68	19.44
Liberian	1	4.62	11.99	3.15	64.63	1.075	4.22	11.83
Mastodon	1	4.25	8.98	1.48	66.23	1.057	3.25	8.06
Honduras	1	4.31	11.89	1.99	62.82	1.072	5.59	11.14
Sugar Cane	2	9.04	11.54	5.32	131.70	2.096	....	....
Hybrid No. 4	1	5.11	3.81	2.85	70.02	1.040	....	....
White Imphee	1	2.57	12.49	1.84	66.91	1.068	8.08	11.28
Goose Neck	1	4.46	10.25	1.76	64.26	1.065	4.03	9.14
White African	1	2.42	9.27	2.20	65.17	1.058	4.65	....
West India Sugar Cane	1	2.53	15.78	2.09	67.18	1.083	11.16	15.26
Sugar Cane	1	4.84	3.94	2.35	69.50	1.042	....	....
New Variety, of Liberian and Oomseeana.	2	9.50	11.46	4.88	131.98	2.096	....	5.86
Minnesota Early Amber	4	13.08	37.64	9.68	284.32	4.180	4.88	....
Holcus Saccharatus	1	2.27	7.95	3.73	42.91	1.057	1.95	6.09
Holcus Sorghum	1	1.00	5.32	4.16	43.07	1.044	.16	3.87
Holcus Cernua, White	1	.90	10.39	5.13	47.96	1.063	4.26	....
Honey Cane	1	4.47	7.08	2.51	71.94	1.052	.10	6.66
Total	60	198.11	525.69	155.71	4,074.53	63.385	.....	396.07
Average	......	3.30	8.76	2.60	67.91	1.056	2.86	9.21

TENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
Early Amber	2	5.82	18.52	5.62	120.00	2.114	7.08	18.38
Early Golden	2	4.96	22.28	3.20	133.90	2.122	14.12	20.54
White Liberian	1	2.38	11.84	2.25	60.40	1.065	6.71	10.90
Do	1	2.48	11.02	1.56	65.79	1.062	6.96	10.67
Black Top	1	3.63	6.25	3.86	78.481	1.044	....	....
Black Tall	1	.68	15.75	5.18	55.15	1.087	9.89	....
African	1	2.32	7.84	2.30	65.20	1.051	3.22	7.53
White Mammoth	2	3.98	28.16	5.82	125.96	2.158	18.36	27.20
Oomseeana	2	3.10	17.00	6.38	131.06	2.102	7.52	13.46
Regular Sorgho	3	3.43	23.46	10.20	183.09	3.156	3.01	23.52
Link's Hybrid	1	1.55	13.42	2.60	64.88	1.071	9.27	....
Do	2	4.10	25.26	5.20	128.14	2.142	15.96	24.[illegible]
Sugar Cane	1	1.10	15.14	2.48	61.81	1.079	11.56	14.82
Goose Neck	1	3.01	8.84	2.84	68.81	1.058	2.99	8.15
Bear Tail	3	9.12	16.83	13.38	204.60	3.156	....	20.43
Iowa Red Top	2	5.94	19.34	4.64	137.26	2.116	8.76	14.30
New Variety	5	16.80	39.10	14.25	355.30	5.260	3.06	30.40
Early Orange	1	3.61	11.88	3.23	65.39	1.071	5.04	11.38
Do	1	3.98	13.81	3.63	62.26	1.063	6.20	13.65
Orange Cane	1	3.66	12.83	1.68	65.78	1.078	7.49	12.66
Neeazana	1	4.63	9.33	2.44	64.58	1.064	2.26	8.94
Wolf Tail	1	2.51	14.69	1.82	55.92	1.078	10.36	....
Gray Top	1	2.72	14.38	2.89	61.00	1.078	8.77	13.28
Liberian	1	4.07	11.83	1.29	67.01	1.070	6.47	11.43
Mastodon	1	6.09	4.66	1.00	66.26	1.046	....	4.14
Honduras	2	6.64	27.64	4.78	130.36	2.150	16.22	26.34
Sugar Cane	1	3.92	6.63	1.97	68.42	1.046	.74	6.28
Hybrid No. 4	1	4.96	5.75	1.73	70.37	1.045	....	5.52
White Imphee	1	2.74	8.581	1.62	70.02	1.051	4.22	7.80
Goose Neck	1	2.05	11.59	4.34	53.71	1.065	5.20	....
White African	1	2.26	8.11	4.15	65.08	1.054	1.71	....
West India Sugar Cane	1	1.89	17.44	4.33	60.86	1.088	11.22	17.74
Sugar Cane	1	4.10	6.62	3.07	65.73	1.051	....	....
New Variety, of Liberian and Oomseeana	2	3.42	15.80	7.32	133.86	2.114	.06	15.32
Minnesota Early Amber	2	5.28	21.00	4.48	127.96	2.120	11.24	21.62
Holcus Saccharatus	1	2.10	7.23	3.27	44.44	1.051	1.86	5.55
Holcus Sorghum	1	.81	4.24	4.31	43.89	1.042	....	3.79
Holcus Cernua, White	1	.60	9.34	3.56	49.51	1.055	5.16	....
Honey Cane	1	5.49	9.02	2.36	66.54	1.061	1.17	7.90
Total	53	157.31	530.13	153.89	3,489.94	56.255	....	435.70
Average	......	2.96	10.00	2.90	65.84	1.061	4.14	8.47

ELEVENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	2.47	12.25	2.87	64.66	1.066	6.91	11.18
Early Golden	1	1.76	13.84	2.91	64.26	1.072	9.17	12.08
White Liberian	1	1.49	14.39	3.36	64.02	1.073	9.54	12.96
Do	1	1.63	14.60	1.85	63.75	1.073	11.12	12.58
Black Top	1	1.15	9.31	3.46	68.54	1.049	4.60	8.12
Black Tall	1	.78	11.97	7.841	56.41	1.065	3.851	....
African	1	3.03	6.52	4.31	68.83	1.050	....	7.01
White Mammoth	2	3.76	31.46	4.82	130.10	2.156	22.88	....
Oomseeana	1	1.95	5.67	2.38	66.71	1.039	1.34	5.10
Regular Sorgho	1	1.86	8.60	2.87	65.52	1.054	3.87	....
Link's Hybrid	2	3.48	31.70	5.34	119.26	2.164	22.88	31.06
Do	2	3.38	31.60	5.18	128.08	2.164	23.04	30.46
Sugar Cane	1	1.74	14.88	1.98	62.57	1.075	11.16	....
Goose Neck	1	1.89	12.98	1.98	61.24	1.068	9.11	....
Bear Tail	1	3.94	3.77	7.15	67.93	1.056	....	7.[illegible]
Iowa Red Top	1	1.77	11.69	3.31	68.39	1.061	6.61	11.18
New Variety	1	1.61	14.54	3.37	65.42	1.073	9.56	....
Early Orange	1	3.33	15.95	2.31	61.26	1.068	10.31	15.41
Do	1	2.81	16.54	2.52	61.96	1.088	11.21	16.23
Orange Cane	1	3.31	15.22	3.58	64.17	1.086	8.33	15.16
Neeazana	1	3.71	13.24	1.45	60.19	1.076	8.08	12.[illegible]
Wolf Tail	1	1.80	16.50	3.20	59.32	1.086	11.50	....
Gray Top	1	4.57	9.65	1.11	69.65	1.063	3.97	....
Liberian	1	5.58	11.66	2.30	65.97	1.075	3.78	10.60
Mastodon	1	1.45	14.80	2.96	58.62	1.075	10.39	12.[illegible]

ELEVENTH STAGE—Continued.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Honduras	1	8.26	13.45	1.92	67.92	1.073	8.27	11.65
Sugar Cane	1	3.44	6.31	5.24	68.48	1.040	....	....
Hybrid No. 4	4	17.36	33.60	10.64	260.48	4.216	5.60	32.56
White Imphee	1	1.77	15.52	1.67	64.60	1.079	12.08	15.05
Goose Neck	1	3.28	11.16	2.85	65.32	1.066	5.53	10.68
White African	1	3.10	11.32	2.88	65.43	1.066	5.34	10.94
West India Sugar Cane	1	2.30	17.64	2.94	62.61	1.090	12.40	15.18
Sugar Cane	1	4.92	3.19	3.04	66.36	1.040	....	3.09
New Variety, of Liberian and Oomseeana	1	3.10	12.30	2.22	59.39	1.067	6.98	11.76
Minnesota Early Amber	2	4.54	22.52	9.18	131.00	2.130	4.40	17.96
Holcus Saccharatus	1	1.57	5.53	4.83	44.55	1.047	....	....
Holcus Sorghum	1	.87	3.08	3.81	30.66	1.031	....	2.29
Holcus Cernus, White	1	.94	10.28	5.89	50.10	1.062	3.45	10.26
Honey Cane	2	10.38	17.04	2.96	139.28	2.118	3.50	14.74
Total	44	120.70	528.38	128.95	2,747.36	46.989	....	379.90
Average	......	2.74	12.01	2.93	62.44	1.068	6.34	11.14

TWELFTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	1.86	12.96	5.04	63.37	1.072	6.06	12.82
Early Golden	1	1.33	14.64	4.96	60.76	1.075	8.35	14.22
White Liberian	1	1.34	14.64	4.74	63.79	1.076	8.56	14.03
Do	1	1.57	14.86	3.99	63.22	1.075	9.29	14.22
Black Top	1	3.41	10.07	2.30	63.77	1.061	4.36	9.44
African	1	2.92	6.76	1.98	65.18	1.046	1.86	6.25
White Mammoth	2	2.98	32.20	13.50?	71.78	2.168	15.72	....
Oomseeana	1	3.57	5.49	1.83	66.18	1.042	.04	5.30
Regular Sorgho	1	1.98	8.29	2.76	59.38	1.051	3.55	7.51
Link's Hybrid	1	1.50	14.80	3.28	65.86	1.080	10.02	....
Do	1	1.38	15.58	3.51	65.11	1.082	10.69	....
Sugar Cane	1	1.36	15.60	3.01	60.13	1.082	11.28	....
Goose Neck	1	2.59	10.28	2.14	65.26	1.062	5.55	9.80
Bear Tail	1	2.62	12.05	2.15	64.02	1.070	7.28	11.79
Iowa Red Top	1	1.35	13.72	1.96	57.69	1.068	10.41	11.43
New Variety	2	4.70	26.84	3.52	134.68	2.144	18.62	25.58
Early Orange	1	2.46	17.26	3.19	58.16	1.091	11.61	16.74
Do	1	2.81	16.95	2.71	59.96	1.090	11.43	16.57
Orange Cane	1	3.27	16.34	1.65	57.44	1.087	11.42	15.31
Neeazana	1	4.67	7.50	1.83	68.70	1.057	1.00	7.28
Wolf Tail	2	3.22	33.86	6.22	123.06	2.172	24.42	....
Gray Top	1	3.61	12.64	3.05	68.20	1.075	5.98	12.19
Liberian	2	2.68	31.76	5.30	126.28	2.156	23.78	29.38
Mastodon	1	1.20	15.48	2.85	64.81	1.072	11.43	13.47
Honduras	2	10.20	19.32	5.52	142.40	2.130	3.60	17.26
Sugar Cane	1	3.24	4.00	2.91	67.82	1.039	....	....
Hybrid No. 4	1	3.34	11.66	2.37	69.05	1.065	5.95	11.25
White Imphee	1	1.15	16.85	3.25	58.33	1.082	12.45	16.34
Goose Neck	1	2.21	13.14	2.58	46.09	1.068	8.35	12.32
White African	1	2.03	13.36	3.24	61.75	1.073	8.09	....
West India Sugar Cane	1	1.70	18.87	3.07	62.55	1.087	14.10	....
Sugar Cane	1	4.30	9.09	1.71	71.32	1.059	3.08	....
New Variety, of Liberian and Oomseeana	1	3.02	13.03	3.20	68.78	1.075	6.81	12.71
Minnesota Early Amber	1	1.47	15.40	1.76	64.60	1.060	12.17	14.19
Holcus Saccharatus	1	.87	3.87	5.58	46.42	1.042	....	3.98?
Holcus Sorghum	1	.92	10.17	4.13	34.98	1.064	5.12	....
Holcus Cernus, White	1	1.16	12.16	5.13	34.49	1.070	4.87	....
Honey Cane	1	5.68	6.97	2.32	69.03	1.035	....	5.95
Total	40	98.72	522.35	119.45	2,500.01	42.847	....	343.85
Average		2.47	13.06	2.98	62.50	1.071	7.61	11.45

THIRTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Early Amber	1	1.57	14.27	3.30	64.51	1.071	9.40	13.89
Early Golden	1	1.16	14.57	4.02	64.31	1.078	9.39	....
White Liberian	1	.92	16.90	3.15	62.18	1.082	12.83	16.18
Do	1	1.34	16.35	1.43	62.58	1.072	13.58	....
Black Top	1	.73	15.17	2.94	68.00	1.077	11.50	....
Black Tail	1	.87	12.27	3.77	45.16	1.070	7.63	....
African	1	1.87	11.78	2.73	63.58	1.068	7.18	11.12
White Mammoth	2	3.52	31.64	5.30	124.02	2.166	22.82	30.46
Oomseeana	1	.87	13.17	2.79	61.66	1.069	9.51	12.84
Regular Sorgho	1	1.40	11.56	3.42	42.14	1.068	6.74	....
Link's Hybrid	1	1.10	16.85	2.82	54.30	1.078	12.93	....
Do	1	1.58	16.41	2.43	63.20	1.082	12.40	....
Sugar Cane	2	3.12	30.36	6.02	132.96	2.152	21.22	28.40
Goose Neck	1	4.03	6.70	1.06	66.88	1.048	1.61	5.04
Bear Tail	1	2.56	12.99	2.35	65.51	1.075	8.08	13.20
Iowa Red Top	1	.93	13.83	2.71	64.90	1.073	10.19	14.04
New Variety	1	1.01	17.19	1.62	61.19	1.082	14.56	16.41
Early Orange	1	2.51	17.68	2.49	57.82	1.089	12.68	....
Do	1	3.56	16.93	3.34	58.01	1.091	10.03	16.99
Orange Cane	1	2.97	17.22	2.81	59.96	1.091	11.44	16.87
Neeazana	1	2.12	13.59	2.40	62.34	1.071	9.07	....
Wolf Tail	1	3.04	14.41	3.30	64.82	1.084	8.07	....
Gray top	1	1.87	15.97	4.20	60.16	1.084	9.90	14.79
Liberian	1	6.74	9.96	2.27	67.77	1.075	.95	9.43
Mastodon	1	4.24	11.89	2.58	65.58	1.074	5.07	11.50
Honduras	1	2.55	14.23	5.43	59.56	1.076	6.25	13.74
Sugar Cane	1	3.58	9.57	2.92	66.85	1.064	3.07	....
Hybrid No. 4	1	3.27	12.20	2.43	66.25	1.070	6.60	11.48
White Imphee	1	1.47	14.97	3.57	65.05	1.074	9.93	....
Goose Neck	1	1.89	13.85	2.39	61.14	1.070	9.57	....
White African	1	2.00	14.25	2.24	60.34	1.073	10.01	13.30
West India Sugar Cane	1	2.52	14.47	4.26	57.56	1.081	7.67	....
Sugar Cane	1	4.06	5.67	1.98	68.62	1.046	....	4.29
New Variety of Liberian and Oomseeana.	1	3.18	12.88	2.67	52.47	1.073	7.03	11.55
Minnesota Early Amber	1	1.51	15.64	4.08	58.93	1.081	10.05	....
Holcus Saccharatus	1	1.55	4.72	4.81	48.10	1.046	....	3.81
Holcus Sorghum	1	.87	8.82	6.28	38.27	1.058	1.67	8.32
Holcus Cernus, White	1	.62	14.58	4.24	49.29	1.075	9.72	....
Total	37	81.66	517.39	107.22	2,180.20	39.778	....	285.36
Average		2.21	13.98	2.90	58.92	1.075	8.87	12.97

FOURTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	1	1.55	14.83	3.93	63.39	1.083	9.35	....
Early Golden	1	1.69	14.48	2.67	58.50	1.077	10.12	....
White Liberian	1	1.31	15.15	3.26	61.94	1.080	10.68	14.25
Do	1	1.30	16.59	2.21	65.43	1.082	13.08	15.72
Black Top	2	2.36	30.80	6.10	124.64	2.164	22.34	31.40
Black Tail	1	.69	13.28	3.73	53.97	1.073	8.86	....
African	1	2.96	8.31	1.60	68.12	1.057	3.75	....
White Mammoth	1	1.62	15.65	1.52	63.64	1.080	12.51	....
Oomseeana	1	.81	15.33	2.66	60.46	1.077	11.86	....
Regular Sorgho	1	2.12	10.85	1.58	62.52	1.061	7.15	....
Link's Hybrid	1	1.79	14.94	7.16	61.09	1.082	5.99	....
Do	2	2.76	35.26	6.96	125.62	2.176	25.54	34.29
Sugar Cane	1	1.27	16.57	2.49	63.41	1.082	12.81	....
Goose Neck	1	3.53	10.93	1.51	71.71	1.064	5.89	....
Bear Tail	1	2.16	12.88	3.29	58.49	1.069	7.43	....
Iowa Red Top	1	1.08	13.92	3.58	64.28	1.071	9.26	12.29
New Variety	1	1.15	16.40	3.96	58.41	1.083	11.29	16.53
Early Orange	1	5.78	12.78	2.34	71.41	1.081	5.26	....
Do	1	3.70	13.17	2.64	64.29	1.076	6.83	12.70
Orange Cane	1	3.43	17.38	2.79	58.11	1.093	11.16	14.41
Neeazana	1	5.04	10.48	.59	61.53	1.065	4.85	9.03
Wolf Tail	1	1.53	16.02	6.49	62.50	1.094	8.00	....
Gray Top	2	6.00	28.26	6.20	123.42	2.160	16.06	....
Liberian	1	4.71	13.00	3.65	67.62	1.081	4.64	13.19
Mastodon	2	3.02	28.86	5.96	132.00	2.146	19.88	26.70

FOURTEENTH STAGE—Continued.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Sugar Cane	1	2.62	13.56	2.23	66.60	1.073	8.71	12.92
Hybrid No. 4	1	8.00	12.78	2.18	65.00	1.066	7.60	12.04
White Imphee	1	1.20	18.24	2.25	60.95	1.088	14.79	17.14
Goose Neck	1	2.07	15.18	8.10	60.84	1.076	10.01	13.47
White African	1	1.80	14.44	2.04	52.33	1.072	10.60	14.28
Sugar Cane	1	8.35	11.57	1.57	62.55	1.067	6.65	10.89
New Variety, of Liberian and Oomseeana	1	8.15	14.03	1.28	72.04	1.075	9.60	12.62
Minnesota Early Amber	1	1.56	14.72	8.00	79.48	1.076	10.16	....
Holcus Saccharatus	1	1.37	4.83	5.27	48.48	1.046	....	4.56
Holcus Sorghum	1	.90	11.04	4.69	51.13	1.064	5.45	....
Holcus Cernua, White	1	.99	12.57	4.19	82.36	1.073	7.39	....
Total	37	82.10	530.64	106.52	2,351.29	39.850	....	295.78
Average	......	2.22	14.34	2.88	63.54	1.077	9.24	14.08

FIFTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	3	2.85	48.09	8.91	175.85	3.255	36.38	....
Early Golden	3	4.65	44.08	10.95	177.42	3.246	30.48	....
White Liberian	2	1.92	35.04	5.60	116.48	2.174	27.52	33.86
Do	2	2.08	35.02	4.40	124.06	2.170	28.54	33.94
Black Top	1	.46	17.08	4.44	59.56	1.087	12.18	....
African	2	2.56	33.24	4.34	124.20	2.152	26.84	....
White Mammoth	1	.82	10.29	7.27?	58.01	1.087	8.10?	....
Oomseeana	2	3.92	29.96	8.02	127.82	2.150	23.02	27.76
Regular Sorgho	1	2.24	14.67	2.97	58.35	1.081	9.46	14.33
Link's Hybrid	1	.83	17.86	8.30	57.69	1.089	13.64	....
Do	1	.66	18.86	8.33	54.59	1.094	14.87	....
Sugar Cane	1	1.09	16.84	8.21	61.61	1.083	12.54	16.36
Goose Neck	1	1.54	15.93	2.51	58.83	1.081	11.88	....
Bear Tail	1	2.44	15.93	1.90	59.52	1.083	11.59	....
Iowa Red Top	1	1.13	17.07	1.77	54.85	1.082	14.17	....
New Variety	1	1.65	17.25	2.28	61.11	1.086	13.32	....
Early Orange	1	2.29	17.38	4.94	55.77	1.093	10.15	....
Do	1	2.58	16.46	8.98	58.05	1.086	9.90	....
Orange Cane	1	3.56	14.12	3.09	65.38	1.083	7.47	14.60
Neeazana	1	3.46	14.50	2.85	61.96	1.081	8.19	14.07
Wolf Tail	1	1.09	18.69	6.59	59.77	1.090	11.01	....
Gray Top	1	4.62	9.65	4.92	68.57	1.068	.11	9.42
Liberian	1	2.94	14.23	4.41	59.04	1.081	6.88	14.81
Mastodon	1	2.64	11.31	5.03	60.07	1.064	3.64	....
Sugar Cane	1	3.56	12.27	2.48	67.00	1.070	6.23	12.25
Hybrid No. 4	1	3.13	13.39	.66	65.06	1.073	9.30	12.70
White Imphee	1	1.48	19.25	2.41	61.06	1.089	15.36	....
Goose Neck	1	1.33	15.59	2.09	57.84	1.078	12.17	....
White African	1	1.82	15.80	2.53	54.36	1.079	12.04	....
West India Sugar Cane	......	....	....	....	....	....	....	....
Sugar Cane	1	8.73	11.55	8.50	65.85	1.070	4.32	10.48
New Variety, of Liberian and Oomseeana	1	8.21	18.55	2.86	60.44	1.078	7.48	13.11
Minnesota Early Amber	1	1.34	15.77	2.45	60.19	1.081	11.98	....
Holcus Saccharatus	1	1.49	5.69	10.54	47.93	1.051	....	....
Holcus Sorghum	1	.82	8.77	5.07	41.95	1.057	2.98	8.62
Holcus Cernua, White	1	2.53	11.96	4.83	83.88	1.074	4.60	....
Honey Cane	......	....	....	....	....	....	....	....
Total	40	73.42	639.81	125.18	2,408.96	43.264	....	227.69
Average	......	1.84	15.99	3.01	60.25	1.082	11.14	14.23

SIXTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
Early Amber	1	1.09	18.43	3.27	52.77	1.091	14.07	....
Early Golden	1	1.26	18.08?	3.73	63.42	1.090	13.09	....
White Liberian	2	2.00	35.30	6.50	121.14	2.172	26.80	....
Do	2	2.46	33.52	4.96	112.74	2.168	26.10	29.12
Black Top	1	.96	19.20	3.09	58.94	1.091	15.15	....
African	3	7.26	40.98	7.47	166.66	3.225	26.25	45.15
Oomseeana	2	4.30	31.24	5.38	127.44	2.160	21.56	24.84
Regular Sorgho	2	2.24	29.08	9.04	107.32	2.158	17.80	....
Link's Hybrid	1	.80	18.18	2.85	58.33	1.090	14.53	....
Do	1	1.03	17.03	2.56	59.56	1.086	13.44	....
Sugar Cane	1	.79	16.12	4.87	60.83	1.088	10.46	17.55
Goose Neck	1	1.60	15.30	2.23	56.53	1.066	11.47	....
Bear Tail	2	4.32	30.90	5.78	124.28	2.166	20.80	....
Iowa Red Top	2	1.74	32.54	7.04	112.42	2.164	23.76	....
New Variety	2	2.24	35.60	6.22	118.86	2.174	27.14	35.16
Early Orange	1	1.54	19.20	2.61	51.49	1.092	15.05	....
Do	1	2.85	17.79	3.55	56.79	1.089	11.39	....
Orange Cane	1	2.00	17.20	4.67	54.48	1.089	10.53	....
Neeazana	1	5.06	9.05	1.47	64.34	1.062	2.52	8.16
Gray Top	1	1.93	13.96	5.05	59.53	1.075	6.98	13.56
Sugar Cane	1	1.73	15.49	3.45	54.94	1.081	10.31	14.80
Hybrid No. 4	1	2.06	14.22	2.71	57.92	1.077	8.85	13.66
White Imphee	1	.86	16.73	4.38	57.02	1.083	11.49	....
Goose Neck	1	1.83	16.00	2.00	60.10	1.077	12.17	....
White African	1	1.50	15.45	4.27	60.22	1.079	9.68	....
Sugar Cane	1	8.78	11.27	2.43	67.18	1.064	5.06	9.32
New Variety, of Liberian and Oomseeana	1	1.98	16.06	4.23	56.53	1.082	9.85	15.72
Minnesota Early Amber	1	1.19	15.98	2.75	59.49	1.079	12.04	....
Holcus Sorghum	1	.81	4.14	6.06	47.75	1.044	....	....
Total	37	63.00	589.90	118.57	2,181.27	40.018	....	227.85
Average	......	1.72	15.94	3.20	58.95	1.081	11.02	14.21

SEVENTEETH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Early Amber	2	1.60	30.84	6.00	107.06	2,180	29.24	32.84
Early Golden	2	1.78	35.30	5.52	115.08	2.172	28.00	32.54
West Liberian	2	1.96	35.04	3.54	121.64	2.170	29.54	31.96
Do	2	1.86	37.60	5.50	114.44	2.186	30.24	....
Black Top	2	2.66	31.12	4.64	123.86	2.160	23.82	....
African	3	4.14	52.41	8.49	158.13	3.267	39.78	43.65
Oomeseeana	2	2.68	34.00	4.40	121.68	2.166	26.92	31.90
Regular Sorgho	2	3.04	32.08	5.52	120.24	2.162	23.52	32.48
Link's Hybrid	1	.34	17.92	7.65?	52.74	1.092	9.93?	....
Do	1	.34	18.28	7.09?	55.21	1.091	10.85?	....
Sugar Cane	1	5.14?	19.51	.05	55.67	1.093	14.32	....
Goose Neck	2	3.14	33.22	6.28	111.34	2.166	23.80	31.64
Bear Tail	2	4.12	33.00	6.06	122.10	2.170	22.82	31.68
Iowa Red Top	2	2.78	34.42	6.58	117.64	2.174	25.06	32.96
New Variety	2	2.78	37.30	5.62	124.60	2.190	28.90	37.40
Orange Cane	1	2.06	15.79	4.52	60.35	1.084	9.21	15.13
Neeazana	2	10.20	25.30	6.48	123.94	2.158	8.62	24.24
Sugar Cane	2	5.90	30.30	4.30	124.12	2.154	20.10	22.18
Hybrid No. 4	2	5.02	31.64	6.22	121.14	2.162	20.40	28.80
Goose Neck	1	1.21	14.37	5.27	57.58	1.079	7.89	....
White African	2	3.66	31.52	5.50	117.18	2.156	22.36	....
Sugar Cane	2	5.92	32.86	4.40	120.48	2.118	22.44	29.80
New Variety, of Liberian and Oomseeana	2	4.96	31.66	7.02	118.22	2.116	19.68	28.58
Minnesota Early Amber	2	2.20	32.92	6.60	118.46	2.156	24.12	30.36
Holcus Cernua, White	1	.68	13.61	4.31	45.27	1.075	8.62	....
Honey Cane	1	2.83	13.07	2.09	61.62	1.070	8.15	12.50
Total	45	82.32	747.47	135.34	2,644.02	48.692	....	500.36
Average	......	1.83	16.61	3.01	56.51	1.082	11.77	14.71

EIGHTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Early Amber	2	2.12	34.64	7.88	93.74	2.178	24.64	....
Early Golden	2	2.68	33.00	6.76	108.18	2.166	23.56	....
White Liberian	2	2.24	32.66	6.10	113.42	2.164	24.82	....
Do	2	2.52	32.56	6.80	106.26	2.170	23.24	....
Black Top	2	2.98	28.22	5.96	114.44	2.154	19.28	....
African	1	.57	17.69	3.12	59.30	1.087	14.00	....
Oomseeana	2	2.98	29.06	3.58	118.70	2.158	22.50	24.60
Regular Sorgho	3	4.22	26.40	4.14	118.18	2.150	18.04	18.10
Sugar Cane	1	.69	15.37	7.06?	59.17	1.081	7.62?	....
Goose Neck	2	2.58	32.38	9.62	116.56	2.158	20.18	....
Bear Tail	2	3.16	32.80	7.54	108.60	2.170	22.10	....
Iowa Red Top	2	1.66	32.80	10.88	117.86	2.164	20.06	....
New Variety	2	1.02	36.00	6.32	114.58	2.180	27.76	....
Early Orange	1	1.52	16.57	3.14	55.84	1.083	11.91	....
Do	1	1.39	18.15	4.40	55.99	1.094	12.36	18.62
Orange Cane	1	1.56	16.68	5.17?	49.29	1.080	9.95	....
Neeazana	2	3.56	30.08	7.90	97.82	2.164	17.02	28.42
Wolf Tail	1	1.03	16.55	4.05	54.09	1.086	10.87	....
Gray Top	1	1.83	14.35	3.74	59.45	1.070	8.78	14.41
Liberian	1	2.10	16.22	3.10	54.72	1.083	11.02	....
Mastodon	1	.70	16.07	3.50	50.03	1.080	11.87	....
Honduras	1	2.56	13.58	2.53	62.85	1.072	8.39	12.77
Sugar Cane	3	12.21	32.46	11.37	184.46	3.213	8.88	31.77
Hybrid No. 4	2	7.98	24.70	5.96	125.02	2.146	10.76	23.24
White African	1	1.33	14.62	4.47	61.09	1.077	8.82	....
Sugar Cane	1	2.57	13.38	4.30	68.81	1.074	6.51	12.99
New Variety, of Liberian and Oomseeana	1	2.14	14.70	3.28	58.64	1.076	9.28	14.04
Minnesota Early Amber	2	3.24	27.42	7.72	120.16	2.142	16.46	....
Total	44	76.23	670.12	160.99	2,517.96	47.540	....	198.96
Average	......	1.75	15.23	3.65	57.22	1.080	9.83	18.26

AFTER EIGHTEENTH STAGE.

Early Amber	13	12.24	164.76	44.88	667.68	12.905	107.64	171.60
Early Golden	12	14.64	168.36	43.92	676.92	12.912	101.80	170.16
White Liberian	12	14.52	171.00	47.26	659.70	12.924	109.32	186.96
Do	12	17.52	158.40	48.36	672.24	12.888	92.52	151.56
Black Top	12	10.92	139.80	47.76	667.08	12.816	81.12	145.44
African	12	21.12	140.28	49.08	669.60	12.852	70.08	146.40
White Mammoth	12	13.32	135.72	51.36	700.92	12.804	71.04	132.84
Oomseeana	9	16.47	75.51	34.20	506.52	9.468	24.84	87.66
Regular Sorgho	12	16.20	146.40	48.48	705.24	12.828	81.72	119.52
Link's Hybrid	12	7.44	178.44	57.36	694.68	12.972	113.64	173.16
Do	12	4.92	180.60	54.60	688.68	12.960	121.08	179.18
Sugar Cane	12	5.40	172.92	51.12	699.00	12.948	116.40	176.04
Goose Neck	12	19.08	144.24	48.24	701.64	12.840	76.92	187.40
Bear Tail	12	23.76	149.76	49.08	709.80	12.876	76.92	150.12
Iowa Red Top	13	20.15	171.21	47.41	759.07	13.949	104.65	237.77
New Variety	12	17.28	155.28	45.84	664.44	12.876	92.16	145.68
Early Orange	12	15.48	151.44	45.72	722.76	12.852	90.24	139.08
Do	12	13.08	166.20	48.00	680.52	12.912	105.12	168.24
Orange Cane	12	16.32	163.08	46.56	722.16	12.900	100.20	155.64
Neeazana	12	18.24	160.20	39.24	718.68	12.852	102.72	158.16
Wolf Tail	13	10.27	182.39	55.64	766.76	14.001	116.48	179.66
Gray Top	13	22.62	144.43	47.58	793.26	13.858	74.23	184.55
Liberian	13	34.84	143.00	49.01	739.47	13.910	59.15	127.40
Mastodon	13	28.08	95.78	45.76	819.26	13.767	47.84	112.97

EIGHTEENTH STAGE—Continued.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
Honduras	18	46.80	96.20	41.86	829.79	18.689	7.34	75.66
Sugar Cane	18	82.89	117.26	46.15	794.43	13.780	38.23	106.34
Hybrid No. 4	13	46.54	89.57	41.21	788.32	13.689	1.82	80.21
White Imphee	12	20.52	100.80	41.52	742.44	12.636	38.64	82.80
Goose Neck	12	24.48	124.68	40.44	713.88	12.768	59.76	114.72
White African	12	14.52	146.76	48.72	671.88	12.852	83.52	149.64
West India Sugar Cane	1	1.37	15.78	3.22	56.02	1.085	11.19	....
Sugar Cane	1	2.26	12.97	2.21	61.05	1.075	8.50	12.68
New Variety, of Liberian and Oomseeana	1	2.17	12.57	2.68	55.23	1.071	7.87	12.29
Minnesota Early Amber	1	1.59	13.55	2.89	56.92	1.072	9.57	13.41
Holcus Saccharatus	1	.53	7.81	4.37	44.82	1.058	2.91	....
Holcus Sorghum	1	.05	3.18	4.04	35.01	1.038	....	6.83
Holcus Cernus, White	1	.47	11.49	4.89	57.27	1.062	6.18	....
Honey Cane	1	1.64	10.95	2.09	57.62	1.065	7.22	10.95
Total	370	638.67	4,400.29	1,418.80	2,1627.72	395.652	....	4,345.99
Average	......	1.726	11.892	3.834	58.45	1.0693	6.33	11.75

AVERAGE RESULTS OF ALL VARIETIES OF MAIZE AT DIFFERENT STAGES.

BEFORE FIRST STAGE.

Egyptian Sugar Corn	1	.94	.25	1.92	67.30	1.016	....	....
Lindsay's Horse Tooth	4	5.52	1.20	6.16	275.80	4.064	....	....
Blount's Prolific	1	1.75	.53	2.53	67.21	1.017	....	....
Total	6	8.21	1.98	10.61	410.31	6.097	....	....
Average	......	1.37	.33	1.77	68.36	1.016	....	....

FIRST STAGE.

Egyptian Sugar Corn	1	1.17	.47	1.52	69.10	1.014	....	....
Lindsay's Horse Tooth	1	2.66	.92	2.42	65.62	1.024	....	....
Blount's Prolific	1	1.48	.25	3.18	56.37	1.018	....	....
Improved Prolific Bread	2	3.82	.46	4.46	131.80	2.032	....	....
Broad White Flat Dent	2	4.98	.52	3.44	131.00	2.038	....	....
Long Narrow White Dent	1	2.21	.23	1.71	68.84	1.019	....	....
Chester County Mammoth	2	7.50	.98	4.38	119.30	2.042	....	....
18-rowed Yellow Dent	1	3.58	.35	1.79	65.36	1.022	....	....
Total	11	27.40	4.18	22.90	707.39	11.209	....	....
Average	......	2.49	.38	2.09	64.39	1.019	....	....

SECOND STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	
Egyptian Sugar Corn	1	2.20	.16	1.31	78.10	1.015	....	....
Lindsay's Horse Tooth	1	3.85	.76	2.37	65.67	1.023	....	....
Blount's Prolific	1	2.79	.16	4.55	68.09	1.020	....	....
Improved Prolific Bread	1	1.83	.42	3.14	62.34	1.020	....	....
Broad White Flat Dent	1	2.50	.59	2.18	66.79	1.023	....	....
Long Narrow White Dent	1	2.41	1.83	3.96	60.27	1.024	....	....
Chester County Mammoth	1	2.97	72	2.91	71.76	1.022	....	....
18-rowed Yellow Dent	1	3.64	.48	3.21	62.38	1.023	....	....
Total	8	22.19	5.12	23.63	535.40	8.166	....	....
Average	......	2.77	.64	2.70	66.92	1.021	....	....

THIRD STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	2	4.66	.74	5.62	133.64	2.036	....	....
Lindsay's Horse Tooth	1	2.39	.58	2.71	67.61	1.020	....	....
Blount's Prolific	1	2.26	1.08	2.57	58.75	1.023	....	....
Improved Prolific Bread	1	2.44	.90	2.03	70.06	1.024	....	....
Broad White Flat Dent	1	3.29	1.16	2.67	58.69	1.025	....	....
Long Narrow White Dent	1	3.54	1.43	2.56	65.97	1.029	....	....
Chester County Mammoth	1	3.85	.16	3.81	60.84	1.022	....	....
18-rowed Yellow Dent	1	2.86	.65	4.89	62.32	1.023	....	....
Total	9	25.29	6.70	26.86	577.98	9.202	....	....
Average	......	2.81	.74	2.98	64.22	1.025	....	....

FOURTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	1	1.32	.74	4.90	64.07	1.019	....	....
Lindsay's Horse Tooth	1	3.28	2.05	2.34	57.50	1.029	....	....
Blount's Prolific	2	5.82	2.54	5.64	124.30	2.048	....	....
Improved Prolific Bread	1	2.86	1.61	2.61	63.35	1.024	....	....
Broad White Flat Dent	1	3.11	1.04	2.97	61.55	1.025	....	....
Long Narrow White Dent	1	3.27	1.04	3.29	65.87	1.026	....	....
Chester County Mammoth	1	3.81	2.00	3.73	56.24	1.032	....	....
18-rowed Yellow Dent	1	2.49	1.89	5.34	63.47	1.028	....	....
Total	9	25.96	12.91	30.82	555.85	9.251	....	....
Average	......	2.88	1.43	3.42	61.76	1.028	....	....

FIFTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	1	2.38	.81	2.19	66.96	1.021	....	....
Lindsay's Horse Tooth	1	2.03	.47	2.46	68.00	1.018	....	....
Blount's Prolific	1	2.50	1.73	2.99	63.80	1.024	....	....
Improved Prolific Bread	2	5.92	2.86	4.56	128.08	2.032	....	....
Broad White Flat Dent	2	6.66	2.74	5.48	140.98	2.054	....	....
Long Narrow White Dent	1	3.48	1.60	2.34	60.27	1.023	....	....
Chester County Mammoth	1	2.74	1.41	4.68	57.67	1.025	....	....
18-rowed Yellow Dent	1	3.86	1.57	2.83	62.84	1.028	....	....
Total	10	29.57	13.29	27.53	648.58	10.245	....	....
Average	......	2.96	1.33	2.75	64.86	1.025	....	....

SIXTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
Egyptian Sugar Corn	1	2.49	2.12	2.30	64.56	1.027	....	....
Lindsay's Horse Tooth	1	2.70	.90	1.86	74.29	1.025	....	....
Blount's Prolific	1	3.82	2.46	2.27	67.90	1.029	....	....
Improved Prolific Bread	1	3.87	1.77	2.87	61.63	1.033	....	1.47
Broad White Flat Dent	1	3.59	1.47	2.81	59.61	1.029	....	1.27
Long Narrow White Dent	1	3.15	3.56	2.10	60.96	1.032	....	2.80
Chester County Mammoth	1	3.17	3.22	2.32	61.68	1.038	....	....
18-rowed Yellow Dent	1	4.21	2.07	2.98	60.17	1.031	....	....
Total	8	27.00	17.57	19.51	510.80	8.244	....	5.54
Average	......	3.37	2.19	2.44	63.85	1.030	....	1.85

SEVENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	1	3.20	.80	1.38	63.67	1.025	....	....
Lindsay's Horse Tooth	2	5.28	1.54	5.80	133.10	2.052	....	....
Blount's Prolific	1	2.61	1.96	3.65	64.84	1.027	....	....
Improved Prolific Bread	1	2.44	2.31	2.68	61.39	1.029	....	2.16
Broad White Flat Dent	1	3.74	3.12	2.02	66.93	1.036	....	2.83
Long Narrow White Dent	1	3.69	3.05	2.16	56.83	1.033	....	....
Chester County Mammoth	1	3.74	2.13	3.33	55.96	1.034	....	....
18-rowed Yellow Dent	1	3.95	2.23	2.67	60.09	1.028	....	....
Total	9	28.74	17.23	23.69	562.81	9.263	....	4.99
Average	......	3.09	1.91	2.63	51.42	1.029	....	2.49

EIGHTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	3	8.82	12.09	8.70	191.49	3.093	....	....
Lindsay's Horse Tooth	1	2.36	2.08	3.03	68.56	1.024	....	....
Blount's Prolific	1	1.59	2.93	2.47	65.37	1.029	....	....
Improved Prolific Bread	2	5.06	9.50	5.62	131.48	2.076	....	8.40
Broad White Flat Dent	1	3.66	4.29	2.62	59.46	1.040	....	3.75
Long Narrow White Dent	2	6.72	11.14	6.22	119.54	2.090	....	10.72
Chester County Mammoth	3	7.59	16.17	8.58	174.03	3.114	....	17.13
18-rowed Yellow Dent	1	3.96	3.36	1.40	61.03	1.032	....	....
Total	14	39.76	61.56	38.64	870.96	14.498	....	40.00
Average	......	2.84	4.39	2.76	62.21	1.035	....	5.00

NINTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	2	5.28	8.84	3.68	120.40	2.070	....	....
Lindsay's Horse Tooth	2	5.66	13.94	4.78	130.78	2.060	3.50	....
Blount's Prolific	1	2.55	4.87	2.50	59.85	1.037	....	....
Improved Prolific Bread	1	2.68	7.58	1.65	57.89	1.049	2.25	7.02
Broad White Flat Dent	1	2.25	9.97	1.33	59.97	1.055	6.39	8.14
Long Narrow White Dent	1	4.50	4.40	1.47	56.90	1.041	....	3.65
Chester County Mammoth	1	2.64	7.76	1.65	56.04	1.050	3.47	....
18-rowed Yellow Dent	1	3.65	5.17	2.92	60.62	1.043	....	....
Total	10	29.21	62.53	19.98	602.51	10.405	....	18.81
Average	......	2.92	6.25	2.00	60.25	1.041	1.33	6.27

TENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
Egyptian Sugar Corn	1	3.07	5.07	2.01	62.95	1.039	....	....
Lindsay's Horse Tooth	1	2.51	7.85	3.44	58.04	1.050	1.90	7.44
Blount's Prolific	2	6.76	11.76	4.80	111.56	2.086	.20	10.22
Improved Prolific Bread	1	3.76	5.20	2.52	52.56	1.045	....	7.01
Broad White Flat Dent	2	5.26	9.30	6.18	108.50	2.080	....	9.26
Long Narrow White Dent	1	4.41	8.32	2.27	59.70	1.053	1.64	8.03
Chester County Mammoth	1	2.92	8.24	1.99	59.55	1.049	3.33	....
18-rowed Yellow Dent	1	3.05	6.87	1.38	54.82	1.044	2.44	6.40
Total	10	31.74	62.61	24.59	567.68	10.446	....	48.36
Average	......	3.17	6.26	2.46	56.77	1.045	.63	6.04

ELEVENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	2	7.30	11.58	4.44	122.90	2.086	....	10.60
Lindsay's Horse Tooth	2	5.70	10.68	5.32	121.42	2.080	....	9.82
Blount's Prolific	2	4.62	9.90	3.96	100.80	2.072	1.32	8.88
Improved Prolific Bread	1	1.33	4.01	5.11	61.60	1.043	....	5.10
Broad White Flat Dent	1	3.53	4.30	3.04	60.39	1.044	....	4.36
Long Narrow White Dent	1	2.58	6.90	2.48	62.77	1.049	1.84	7.03
Chester County Mammoth	1	3.24	6.16	.73	54.02	1.041	2.19	5.25
18-rowed Yellow Dent	1	3.20	8.24	2.81	54.90	1.052	2.23	7.58
Total	11	31.50	61.77	27.89	639.40	11.467	....	58.62
Average	......	2.86	5.61	2.53	58.13	1.042	.22	5.33

TWELFTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	1	3.22	3.85	2.89	64.33	1.034	....	3.66
Lindsay's Horse Tooth	1	2.70	4.36	3.51	62.29	1.040	....	4.24
Blount's Prolific	2	4.26	7.96	6.34	102.40	2.070	....	7.46
Improved Prolific Bread	2	5.30	12.40	.64	116.08	2.086	6.46	11.80
Broad White Flat Dent	2	5.84	15.28	7.72	125.44	2.094	1.72	12.26
Long Narrow White Dent	1	1.97	10.67	2.32	62.34	1.059	6.38	10.49
Chester County Mammoth	1	2.40	5.82	2.92	57.01	1.041	.50	5.54
18-rowed Yellow Dent	1	3.35	4.15	2.05	55.40	1.036	....	7.48?
Total	11	29.04	64.49	28.39	644.29	11.460	....	55.45
Average	......	2.64	5.86	2.58	58.57	1.042	.64	5.55

THIRTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptain Sugar Corn	2	5.92	10.06	3.06	114.46	2.078	1.08	6.36
Lindsay's Horse Tooth	2	4.76	14.12	3.94	121.84	2.086	5.22	10.52
Blount's Prolific	1	1.63	7.91	2.38	51.84	1.048	3.90	4.87
Improved Prolific Bread	2	4.70	10.44	4.84	124.72	2.080	.90	12.82
Broad White Flat Dent	1	2.84	9.97	2.26	51.40	1.055	4.87	8.73
Long Narrow White Dent	3	7.26	30.69	6.12	158.43	3.171	17.31	34.71
Chester County Mammoth	1	3.36	5.12	1.75	52.41	1.039	.01	4.89
18-rowed Yellow Dent	4	5.88	45.84	8.56	216.48	4.220	31.40	39.08
Total	16	36.35	134.15	32.91	891.58	16.777	....	121.98
Average	......	2.27	8.38	2.06	55.72	1.048	4.65	7.62

FOURTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
Egyptian Sugar Corn	1	2.10	9.27	2.03	53.99	1.053	5.05	7.93
Lindsay's Horse Tooth	1	3.02	6.13	1.59	54.56	1.042	1.51	5.90
Blount's Prolific	1	1.90	7.16	4.33	57.47	1.045	.93	6.97
Improved Prolific Bread	2	4.70	14.72	4.96	120.60	2.088	5.06	13.30
Broad White Flat Dent	1	2.25	12.55	2.50	51.47	1.069	7.80	11.74
Long Narrow White Dent	1	3.16	7.59	2.75	57.73	1.048	1.68	7.28
Chester County Mammoth	1	1.25	2.47	3.08	55.81	1.029	....	2.36
18-rowed Yellow Dent	1	2.80	8.13	3.39	59.38	1.051	1.94	8.34
Total	9	21.27	68.02	24.63	511.01	9.405	....	63.71
Average	......	2.36	7.56	2.74	56.78	1.045	2.46	7.08

FIFTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	1	2.40	11.02	4.14	58.38	1.062	4.48	10.98
Lindsay's Horse Tooth	1	2.92	4.81	3.46	60.50	1.041	....	4.61
Blount's Prolific	1	.69	1.91	4.06	52.52	1.028	....	....
Improved Prolific Bread	1	2.05	4.79	1.95	40.06	1.035	.79	....
Broad White Flat Dent	1	1.15	3.53	2.89	47.03	1.030	....	2.34
Long Narrow White Dent	2	3.16	10.62	7.60	107.10	2.084	....	10.53
Chester County Mammoth	2	3.60	16.64	6.34	110.62	2.100	6.70	24.74
18-rowed Yellow Dent	1	3.22	6.18	2.56	49.64	1.045	.40	....
Total	10	19.19	59.50	31.00	555.85	10.425	....	54.09
Average	......	1.92	5.95	3.10	55.59	1.043	.93	7.73

SIXTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	1	2.74	4.72	3.11	54.71	1.040	....	....
Lindsay's Horse Tooth	1	3.09	7.19	2.67	59.09	1.050	1.43	7.04
Blount's Prolific	1	.70	2.35	3.66	42.62	1.027	....	....
Improved Prolific Bread	1	2.05	4.29	2.83	51.49	1.035	....	3.95
Long Narrow White Dent	1	3.25	9.51	3.24	45.95	1.056	3.02	9.39
Chester County Mammoth	1	1.32	3.78	4.16	41.66	1.036	....	....
18-rowed Yellow Dent	1	2.11	11.39	5.80	50.00	1.063	3.48	11.44
Total	7	15.26	43.23	25.47	345.52	7.306	....	31.82
Average	......	2.18	6.17	3.64	49.36	1.044	.35	7.95

SEVENTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
Egyptian Sugar Corn	2	5.32	26.40	4.14	112.16	2.134	16.94	21.68
Lindsay's Horse Tooth	2	2.30	15.60	5.72	120.92	2.088	7.58	19.06
Blount's Prolific	1	1.36	8.40	2.80	55.22	1.051	4.15	6.06
Improved Prolific Bread	1	1.92	6.50	2.00	63.18	1.041	2.58	....
Long Narrow White Dent	1	1.84	12.11	2.52	56.00	1.065	7.75	....
Chester County Mammoth	2	2.94	17.86	5.72	105.18	2.103	8.20	....
18-rowed Yellow Dent	1	1.20	4.35	2.12	87.94	1.030	1.63	....
Total	10	16.88	91.22	25.11	550.60	10.511	....	46.80
Average	......	1.60	9.12	2.51	55.06	1.051	4.93	9.36

EIGHTEENTH STAGE.

Variety.	Number of determinations.	Glucose.	Sucrose.	Solids not sugar.	Average juice.	Average specific gravity.	Available sucrose.	Per cent. sucrose by polarization.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
Egyptian Sugar Corn	1	2.50	7.58	1.05	53.63	1.047	4.03	....
Lindsay's Horse Tooth	1	1.60	11.57	2.56	50.91	1.061	7.41	10.49
Blount's Prolific	1	1.92	6.95	3.13	49.67	1.041	1.90	7.15
Improved Prolific Bread	1	1.61	3.31	2.54	54.95	1.031	....	2.08
Long Narrow White Dent	2	5.06	20.88	4.36	110.94	2.116	11.46	20.50
Chester County Mammoth	1	1.44	5.94	2.43	46.77	1.039	2.07	5.20
18-rowed Yellow Dent	2	3.14	23.30	5.28	127.06	2.114	14.88	21.70
Total	9	17.27	79.53	21.35	493.93	9.449	....	67.12
Average	......	1.92	8.83	2.37	54.88	1.049	4.54	8.39

GENERAL RESULTS OF ANALYSES OF MAIZE BY STAGES.

Before first stage	6	1.37	.33	1.77	68.36	1.016	....	....
First stage	11	2.49	.38	2.09	64.39	1.019	....	....
Second stage	8	2.77	.64	2.70	66.92	1.021	....	....
Third stage	9	2.81	.74	2.98	64.22	1.025	....	....
Fourth stage	9	2.88	1.43	3.42	61.76	1.028	....	....
Fifth stage	10	2.96	1.33	2.75	64.86	1.025	....	....
Sixth stage	8	3.37	2.19	2.44	63.85	1.030	....	1.85
Seventh stage	9	3.09	1.91	2.63	51.42	1.029	....	2.49
Eighth stage	14	2.84	4.30	2.76	62.20	1.035	....	5.00
Ninth stage	10	2.92	6.25	2.00	60.25	1.041	1.33	6.27
Tenth stage	10	3.17	6.26	2.46	56.77	1.045	.63	6.04
Eleventh stage	11	2.86	5.61	2.53	58.13	1.042	.22	5.33
Twelfth stage	11	2.64	5.86	2.58	58.57	1.042	.64	5.55
Thirteenth stage	16	2.27	8.38	2.06	55.72	1.048	4.05	7.62
Fourteenth stage	9	2.36	7.56	2.74	56.78	1.045	2.46	7.08
Fifteenth stage	10	1.92	5.95	3.10	55.59	1.043	.93	7.73
Sixteenth stage	7	2.18	6.17	3.64	49.36	1.044	.35	7.95
Seventeenth stage	10	1.69	9.12	2.51	55.06	1.051	4.92	9.36
Eighteenth stage	9	1.92	8.83	2.37	54.88	1.049	4.54	8.39

AVERAGE RESULTS FOR 1879, 1880, 1881.

From the general averages of the tables just given the following table has been prepared, giving the percentages of sucrose, glucose, solids, available sugar, and juice, as also the specific gravity, and the number of separate analyses included in the average for each stage.

For purpose of comparison, there is also given upon the same table the average results obtained in 1879 and 1880, and finally an average of all the results for the three years.

The same results are graphically represented upon the four charts which follow, the line for juice being left out in the chart giving the results of 1879, since, as has been explained in a previous report, the juice was obtained that year without the aid of a mill, and was so much less in consequence as not to be comparable with the results obtained the last two years. This final chart comprises, as will be seen, the average results of a total of 4,032 separate analyses of some forty-five varieties of sorghum, and, covering the record of three years' work, the results are the more conclusive.

Average results for 1879, 1880, 1881.

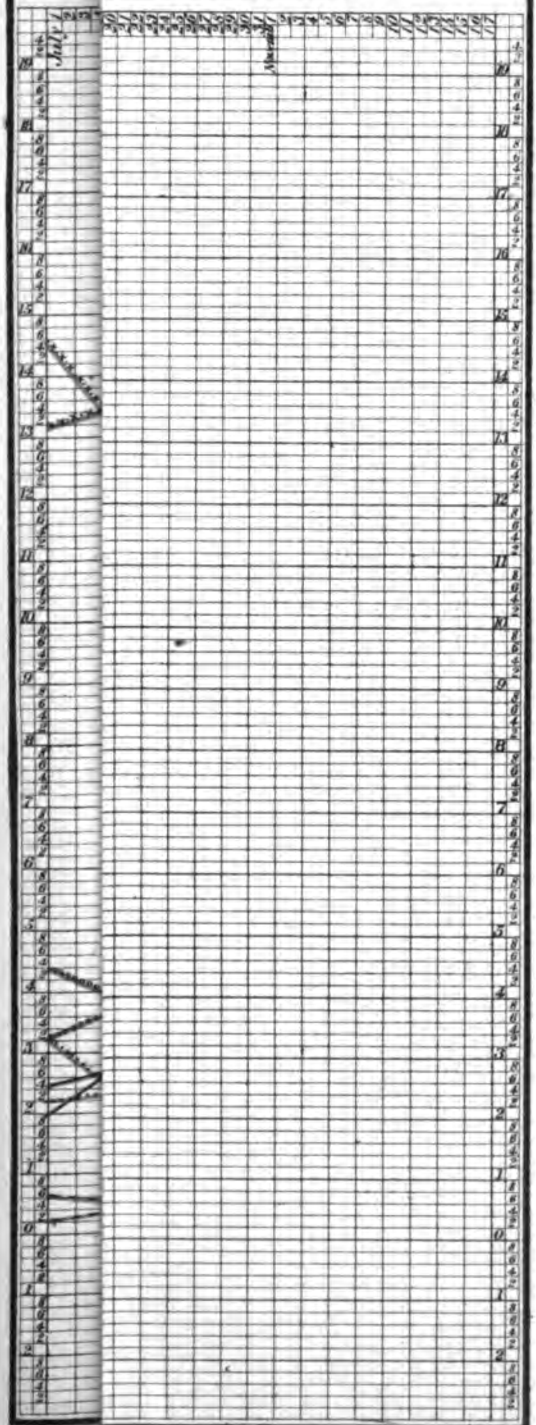
Development.	Per cent. sucrose.			Per cent. glucose..			Per cent. solids.		
	1879.	1880.	1881.	1879.	1880.	1881.	1879.	1880.	1881.
First stage	....	1.76	.89	....	4.29	2.31	....	1.75	2.40
Second stage	1.20	2.96	1.20	5.13	4.45	3.24	....	1.86	2.41
Third stage	....	3.51	1.84	....	4.50	3.35	....	1.78	2.41
Fourth stage	....	4.34	2.02	....	4.34	3.41	....	1.91	2.90
Fifth stage	3.94	5.13	2.78	4.65	4.15	3.41	1.40	1.92	3.18
Sixth stage	3.62	6.50	3.60	5.55	3.99	3.69	1.56	2.45	2.78
Seventh stage	7.07	7.38	4.71	3.87	3.86	3.88	1.71	2.19	2.81
Eighth stage	6.18	7.69	6.08	4.47	3.83	3.69	1.36	2.37	3.03
Ninth stage	9.72	8.95	7.47	3.60	3.10	3.70	1.45	2.42	2.63
Tenth stage	8.04	9.98	8.76	3.27	2.60	3.30	1.53	2.50	2.60
Eleventh stage	11.54	10.66	10.00	2.81	2.35	2.96	1.42	2.72	2.90
Twelfth stage	14.15	11.18	12.01	1.58	2.07	2.74	2.52	2.83	2.93
Thirteenth stage	14.37	11.40	13.06	1.46	2.03	2.47	1.51	2.82	2.98
Fourteenth stage	12.44	11.76	13.98	1.16	1.88	2.21	2.93	2.96	2.90
Fifteenth stage	14.26	11.69	14.34	1.74	1.81	2.22	3.01	3.15	2.88
Sixteenth stage	14.37	12.40	15.99	1.12	1.64	1.84	2.02	3.32	3.01
Seventeenth stage	13.84	13.72	15.94	.93	1.56	1.72	3.13	4.07	3.20
Eighteenth stage	8.45	11.92	16.61	.70	1.85	1.83	3.22	3.42	3.01
Nineteenth stage	14.75	12.08	15.23	.82	3.09	1.75	2.60	3.62	3.65
Twentieth stage	14.13	....	11.89	1.50	....	1.73	3.13	....	3.83

Development.	Specific gravity.			Per cent. of juice.			Per cent. available sugar.		
	1879.	1880.	1881.	1879.	1880.	1881.	1879.	1880.	1881.
First stage	....	1.031	1.018	....	59.06	65.30	....	—4.28	—3.82
Second stage	1.035	1.036	1.025	34.40	59.60	67.13	—3.93	—3.35	—4.45
Third stage	....	1.037	1.029	....	59.67	69.48	....	—2.77	—3.92
Fourth stage	....	1.041	1.020	....	61.61	68.02	....	—1.91	—4.29
Fifth stage	1.043	1.045	1.032	35.81	63.05	68.18	—2.15	— .94	—3.81
Sixth stage	1.044	1.050	1.035	35.20	62.79	68.07	—3.49	.06	—2.87
Seventh stage	1.061	1.052	1.042	36.65	63.85	67.21	1.49	1.33	—1.98
Eighth stage	1.061	1.055	1.048	33.80	65.68	67.81	.35	1.49	— .64
Ninth stage	1.063	1.058	1.052	32.70	64.88	66.76	—4.67	3.34	1.14
Tenth stage	1.061	1.061	1.056	34.91	64.83	67.91	3.24	4.88	2.85
Eleventh stage	1.068	1.063	1.061	34.35	65.02	65.84	7.31	5.59	4.14
Twelfth stage	1.081	1.065	1.068	31.72	63.39	62.44	10.05	6.28	6.34
Thirteenth stage	1.082	1.066	1.071	30.07	62.99	62.50	11.40	6.55	7.61
Fourteenth stage	1.080	1.067	1.075	30.73	61.72	58.92	8.35	6.92	8.87
Fifteenth stage	1.078	1.067	1.077	29.50	60.45	63.54	9.51	6.73	9.24
Sixteenth stage	1.077	1.070	1.082	27.57	61.20	60.25	11.23	7.44	11.14
Seventeenth stage	1.078	1.078	1.081	21.60	60.17	58.95	9.78	8.09	11.02
Eighteenth stage	1.081	1.060	1.082	26.20	62.09	56.51	4.53	6.65	11.77
Nineteenth stage	1.077	1.080	1.080	22.95	56.04	57.22	11.33	5.37	9.83
Twentieth stage	1.079	....	1.069	25.22	....	58.45	9.50	....	6.79

Development.	Number of analyses.			Average results 1879, 1880, 1881.						
	1879.	1880.	1881.	Sucrose.	Glucose.	Solids.	Specific gravity.	Juice.	Available sugar.	Number of analyses.
				Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	
First stage	......	58	16	1.57	3.86	1.89	1.028	60.41	—4.16	74
Second stage	2	69	38	2.32	4.03	2.05	1.032	62.26	—3.76	109
Third stage	......	57	40	2.82	4.02	2.04	1.033	63.71	—3.24	97
Fourth stage	......	70	52	3.35	3.94	2.33	1.035	64.84	—2.92	122
Fifth stage	8	75	46	4.23	3.89	2.36	1.043	65.00	—2.02	129
Sixth stage	4	62	51	5.16	3.88	2.58	1.045	65.17	—1.30	117
Seventh stage	4	70	42	6.39	3.85	2.41	1.048	65.11	.13	116
Eighth stage	4	111	42	7.23	3.80	2.53	1.053	66.25	.90	157
Ninth stage	4	266	45	8.74	3.26	2.44	1.057	65.15	4.04	315
Tenth stage	8	217	60	9.69	2.76	2.50	1.060	65.49	4.49	285
Eleventh stage	12	166	53	10.53	2.50	2.72	1.062	65.22	5.31	230
Twelfth stage	10	170	44	11.41	2.19	2.84	1.066	63.19	6.38	224
Thirteenth stage	8	183	40	11.75	2.09	2.82	1.068	62.90	6.84	231
Fourteenth stage	8	191	37	12.13	1.92	2.95	1.068	61.26	7.26	236
Fifteenth stage	4	217	37	12.09	1.87	3.11	1.068	60.90	7.11	258
Sixteenth stage	6	339	40	12.79	1.65	3.28	1.071	61.10	7.86	385
Seventeenth stage	6	197	37	14.07	1.57	3.92	1.078	59.98	8.56	240
Eighteenth stage	2	191	45	12.80	1.71	3.34	1.071	61.03	7.75	238
Nineteenth stage	12	30	44	14.01	2.18	3.31	1.080	56.74	8.52	86
Twentieth stage	22	....	370	11.95	1.72	3.81	1.069	58.45	6.42	393
Total	124	2,739	1,179	....	......	......	....	....	....	4,043

Plate XIV.

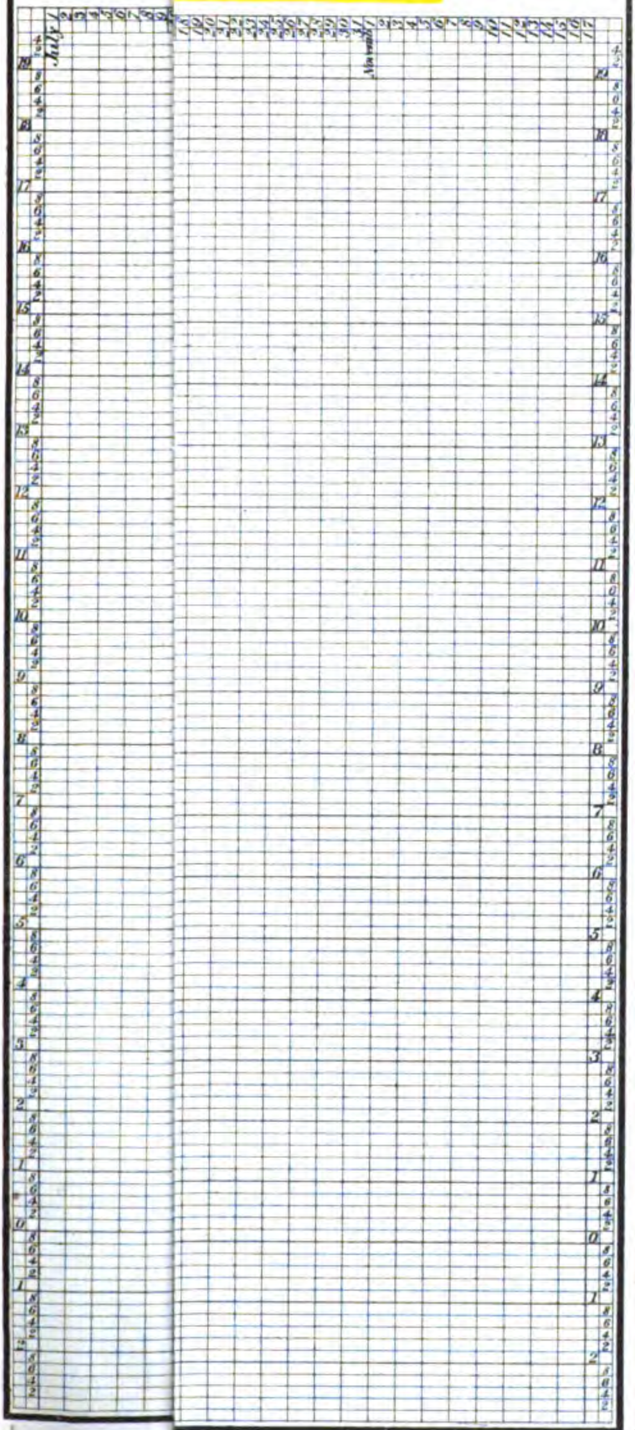
Blount's Prolific.



-o-o-Available Sugar.

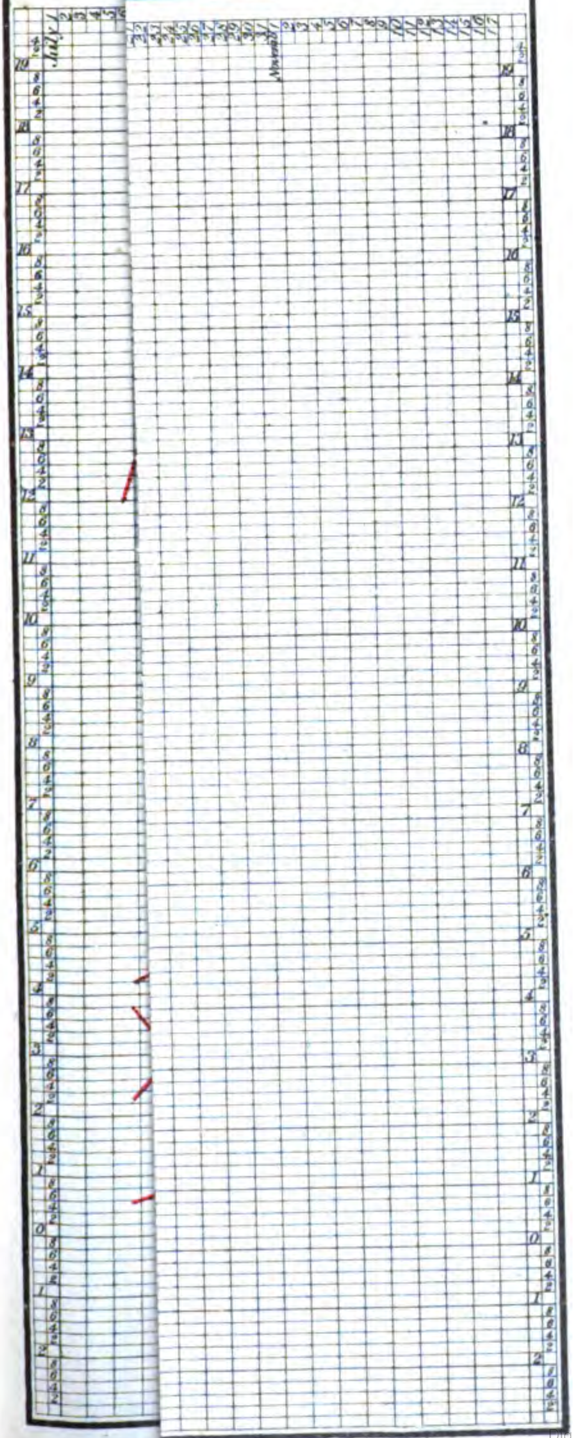
Plate XV.

...rrow White Dent.



o – o – o – Available Sugar.

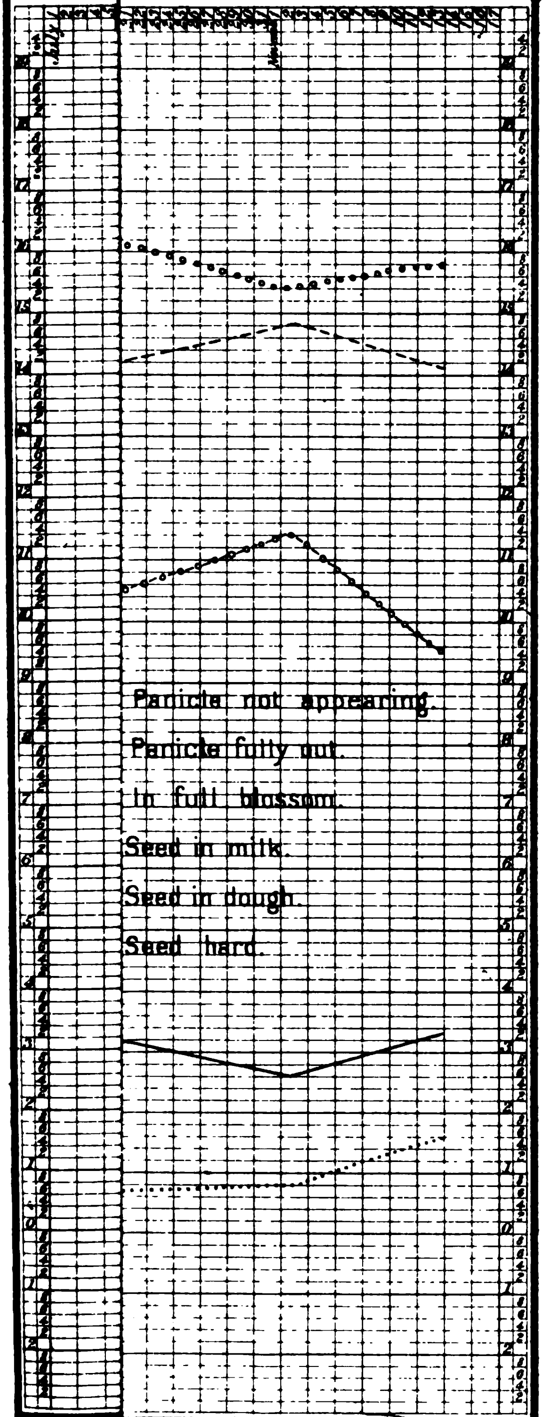
y Dent.



–o–Available Sugar.

Plate XVII.

Analyses 136.



ble Sugar.

COMPARISON OF SUGAR CANE WITH SORGHUM.

The results represented upon the tables and charts which have been given will appear the more surprising if compared with the average analyses of the juices of sugar cane.

Twenty-five samples of sugar cane juices from the many varieties of this plant grown in Louisiana, Cuba, Jamaica, Martinique, Guadelupe, and the East Indies, analyzed by several chemists, give the following average composition: Sucrose, 13.28 per cent.; other solids, 2.71 per cent. If, now, as in the case of the sorghums, we subtract the sum of the solids (which was made up of ash, glucose, and other undetermined substances) from the sucrose,we have as available sugar in these juices, an average of 10.57 per cent., an amount even less than that found present in the average juice of 35 kinds of sorghum for long periods, as will be seen by reference to the charts and tables.

TEMPERATURE AND RAINFALL, 1881.

The following statement, showing the mean temperature and total rainfall for each day, from May 1t o November 30, as also the maximum and minimum temperatures from the date of the first frost, which occurred October 6, has been furnished this department from the records on file at the office of the Chief Signal Officer.

For purpose of comparison, the record of the same character for 1880 is also given.

Statement showing the mean temperature in degrees Fahr. and total precipitation recorded at the station of observation of the Signal Service, United States Army, at Washington, D. C., for each day from May 1 *to November* 30, 1881.

[Compiled from the records on file at the office of the Chief Signal Officer, United States Army, Washington, D. C.]

Day of the month.	1881.*													
	May.		June.		July.		August.		September.		October.		November.	
	Mean temperature.	Total precipitation.	Mean temperature.	Total precipitation.	Mean temperature.	Total precipitation.	Mean temperature.	Total precipitation.	Mean temperature.	Total precipitation.	Mean temperature.	Total precipitation.	Mean temperature.	Total precipitation.
	°	*In.*	°	*In.*	°	*In.*	°	*In.*	°	*In.*	°	*In.*	°	*In.*
1	59.5	......	74.2	.09	70.7	......	77.0	.01	79.1	......	80.3	......	61.0	.16
2	65.4	.11	61.5	.43	73.7	......	76.3	.25	77.0	—	78.0	......	58.4	......
3	52.5	.10	59.7	.13	77.7	......	80.3	......	78.5	......	77.7	......	50.7	.48
4	56.7	......	60.0	.41	80.6	......	81.7	......	77.7	......	72.0	.01	43.0	.02
5	58.5	......	66.0	......	84.7	......	84.7	......	83.5	......	48.3	—	50.8	......
6	60.9	.10	66.5	.02	86.0	.23	84.3	—	81.3	......	51.3	......	53.3	......
7	64.2	......	65.2	.51	80.7	.42	76.6	.71	86.1	......	63.0	......	54.3	.56
8	64.7	......	75.0	—	78.7	.09	71.3	......	83.0	......	68.3	......	63.8	.02
9	71.2	......	62.7	.68	75.7	......	80.0	......	78.2	......	65.3	.43	63.7	.07
10	75.2	......	57.2	.06	80.3	......	83.7	......	78.6	.40	57.0	......	49.3	—
11	70.5	......	70.7	......	82.7	......	74.3	......	76.2	1.33	48.7	......	46.3	.01
12	82.2	......	72.7	......	82.7	—	79.7	—	71.1	......	55.3	.06	54.0	.14
13	84.5	—	68.5	......	82.7	.29	84.3	......	70.7	......	71.3	......	53.0	......
14	72.2	—	75.2	......	82.0	—	74.7	.01	70.6	......	58.7	......	47.5	......
15	76.2	.13	75.2	......	77.3	......	68.7	......	72.4	.11	69.3	......	40.4	......
16	62.0	......	75.5	......	81.0	.08	69.3	......	77.6	.32	75.4	......	38.7	......
17	55.7	.20	78.5	.48	76.2	.24	68.3	......	71.5	.02	72.7	......	48.7	......
18	54.5	.22	77.7	......	72.7	......	68.0	.01	66.0	......	69.4	......	62.7	......
19	56.6	.95	78.5	.01	76.0	......	70.7	......	74.0	......	53.3	......	56.3	.01
20	61.0	.02	76.5	.22	79.3	......	75.8	......	73.3	......	54.7	......	36.0	......
21	65.5	......	72.0	......	76.7	—	78.1	.04	72.7	......	52.5	......	40.8	—
22	69.2	—	66.2	......	67.0	.30	75.7	.04	74.3	......	57.0	......	42.2	—
23	68.5	......	67.5	—	72.7	......	73.8	......	76.0	—	60.6	.02	36.2	.93
24	66.2	......	66.5	......	77.8	......	75.4	......	78.3	......	62.6	1.07	31.3	.02
25	72.0	......	70.6	.05	79.3	......	74.9	......	79.3	......	60.0	.17	28.7	......
26	66.7	......	75.2	......	78.7	......	73.5	......	82.0	......	55.4	......	38.5	......
27	72.5	......	71.5	2.59	74.3	......	71.4	......	81.0	......	54.0	......	44.5	......
28	76.5	......	82.2	......	73.7	......	76.6	......	79.7	.01	58.9	—	40.7	......
29	77.6	......	81.2	.03	70.3	.02	79.7	......	79.7	......	66.3	.40	40.7	......
30	79.7	......	78.2	......	71.7	......	81.1	......	79.3	......	65.3	.46	49.3	.03
31	77.0	.03	......	......	75.7	......	79.4	......	......	......	65.5	.67	......	......

* The dash (—) indicates rainfall too small to measure.

Statement showing the maximum and minimum temperatures in degrees Fahr. from October 6 (date of first frost) to November 30, 1881, as recorded at the station of observation of the Signal Service, United States Army, in Washington, D. C.

[Compiled from the records on file at the office of the Chief Signal Officer, United States Army, Washington, D. C.]

Day.	October.		November.		Day.	October.		November.		Day.	October.		November.	
	Maximum.	Minimum.	Maximum.	Minimum.		Maximum.	Minimum.	Maximum.	Minimum.		Maximum.	Minimum.	Maximum.	Minimum.
1	......	......	65.1	59.0	12	62.8	43.9	59.0	45.3	23	70.6	47.6	30.4	32.0
2	......	......	61.3	57.1	13	88.2	57.8	63.1	45.7	24	66.3	59.5	39.4	25.2
3	......	......	61.8	40.0	14	72.7	53.8	60.1	36.6	25	67.3	54.4	35.0	21.4
4	......	......	48.4	37.2	15	79.2	57.2	50.9	34.0	26	64.3	48.4	47.9	28.2
5	......	......	61.0	35.7	16	88.6	64.0	50.5	28.2	27	66.3	43.7	56.8	29.5
6	63.0	35.4	65.3	40.9	17	83.7	63.1	59.0	32.7	28	65.8	47.1	48.0	36.5
7	72.6	53.0	60.0	48.4	18	85.2	58.8	71.0	45.0	29	70.1	62.1	47.1	30.0
8	80.2	55.6	65.8	59.1	19	60.3	47.2	76.1	45.2	30	68.1	60.8	52.9	41.2
9	75.4	60.0	71.4	55.6	20	65.8	48.2	47.8	33.0	31	69.6	62.6	......	......
10	69.6	48.0	56.8	44.2	21	68.5	42.0	48.4	28.4					
11	60.2	37.0	49.1	48.7	22	70.4	42.2	46.4	37.7					

Frosts, (fall of 1881).—October 6, and 11; November 14, 16, 17, 28, and 29.

Heavy rain-storms, May 1, *to November* 30, 1881.

Date.	Began.	Ended.	Amount.	Remarks.
			Inches.	
June 27	1.20 p. m	8.45 p. m	2.59	All rain-storms, between the dates named, in which the amount of precipitation exceeded one inch are here given.
September 11	4.30 p. m	8.40 p. m	1.33	
October 23 to 25	10.08 p. m., 23d.	8.05 a. m., 25th.	1.26	
October 29 to November 1	2.25 a. m., 29th.	10.15 a. m., Nov. 1	1.69	

Temperature and rainfall, 1881.

Month.	Mean monthly temperature.	Average daily rainfall.
	°*Fahr.*	*Inches.*
May, 1881	67.9	.06
June, 1881	70.9	.19
July, 1881	77.4	.05
August, 1881	76.4	.03
September, 1881	77.0	.07
October, 1881	62.9	.11
November, 1881	47.5	.08

WAR DEPARTMENT, OFFICE OF CHIEF SIGNAL OFFICER,
Washington, D. C., December 24, 1881.

Statement showing the mean temperature in degrees Fahr., and total rainfall recorded at the station of observation of the Signal Service, United States Army, at Washington, D. C., for each day from May 1 to November 30, 1880.

[Compiled from the records on file at the office of the Chief Signal Officer.]

Day of the month.*	May, 1880.		June, 1880.		July, 1880.		August, 1880.		September, 1880.		October, 1880.		November, 1880.	
	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.
	°	In.	°	In.	°	In.	°	In.	°	In.	°	In.	°	In.
1	52.7	......	71.5	.16	73.0	.31	79.5	......	74.7	.02	54.7	......	46.2	......
2	64.7	......	57.2	.24	75.5	.04	82.2	—	72.2	......	59.0	......	50.0	......
3	67.7	......	66.2	......	72.8	......	75.5	1.01	81.7	......	63.2	......	51.5	—
4	67.2	......	70.2	......	75.5	......	71.7	.97	83.0	......	68.2	.28	57.5	.62
5	67.0	......	71.2	......	76.8	.18	67.7	.12	82.5	—	59.5	.48	63.2	.06
6	74.5	......	75.7	......	78.0	......	70.5	......	78.5	.10	61.0	......	66.5	.16
7	66.1	......	78.2	......	80.0	......	74.0	......	68.5	1.26	51.5	......	44.3	.07
8	71.5	......	73.5	......	80.5	.03	72.2	......	61.0	.05	54.5	......	45.3	......
9	77.5	......	67.0	......	83.0	.03	76.2	......	55.5	1.48	58.7	......	47.3	......
10	78.0	......	67.7	.06	84.7	......	77.5	.06	60.2	......	62.5	......	56.5	.43
11	73.0	1.40	79.7	.14	81.2	—	74.7	—	64.2	......	66.7	......	58.3	.15
12	68.5	......	81.0	.23	82.5	......	74.7	......	67.2	......	63.7	—	52.5	......
13	59.7	......	83.2	—	86.5	......	74.7	......	66.0	.36	54.2	......	37.3	.01
14	54.0	......	75.2	.03	83.0	.01	76.5	.12	58.5	......	54.5	......	37.0	.01
15	57.0	......	61.7	2.28	79.2	.02	73.0	.18	59.7	......	66.7	......	36.5	......
16	66.5	......	63.5	.18	81.2	—	68.7	......	65.7	......	72.5	—	38.7	......
17	76.5	......	71.2	......	78.5	......	71.0	......	72.5	......	54.2	.23	43.0	......
18	78.7	......	73.0	......	77.8	—	70.2	.05	74.2	......	47.0	......	35.0	—
19	72.0	......	74.0	......	79.0	......	76.5	.13	74.5	......	44.7	......	29.2	......
20	79.7	......	75.2	......	74.7	.23	79.0	.01	76.2	......	50.0	......	33.2	.09
21	76.7	......	78.2	......	72.0	—	81.5	......	69.7	—	54.7	......	30.7	......
22	66.5	.70	81.0	......	61.5	1.40	79.5	—	61.7	......	56.0	.17	20.5	......
23	66.5	.91	81.5	......	71.0	......	80.2	—	60.0	—	48.0	.20	22.5	......
24	75.0	......	85.0	......	76.7	......	82.0	—	63.5	......	43.5	—	27.2	......
25	82.5	......	81.5	.10	76.2	......	79.2	.65	67.7	......	43.5	......	30.7	.04
26	83.5	......	79.7	.10	80.7	......	68.7	.02	68.7	......	54.7	.01	24.7	.17
27	82.2	......	80.5	—	76.5	—	72.7	......	74.2	......	53.0	.03	29.7	......
28	75.0	.04	83.5	—	72.6	......	78.0	......	61.5	.15	40.0	.23	32.7	.63
29	70.2	—	80.5	—	72.0	......	79.2	.02	60.2	......	46.5	.03	38.7	......
30	72.0	.82	76.7	......	72.0	......	73.0	.25	53.0	......	61.0	.65	33.7	.04
31	74.2	......	......	......	75.7	......	67.7	.11	......	......	50.7	......	......	......

* The dash (—) indicates rainfall too small to measure.

Statement showing the maximum and minimum temperatures in degrees Fahr. from October 1 (date of first frost) to November 30, 1880, as recorded at the station of observation of the Signal Service, United States Army, in Washington, D. C.

[Compiled from the records on file at the office of the Chief Signal Officer, United States Army, at Washington, D. C.]

Day of month.	October, 1880.		November, 1880.		Day of month.	October, 1880.		November, 1880.	
	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.
1	67.0	38.5	58.0	34.5	17	70.0	46.0	51.0	32.0
2	72.0	43.0	63.0	38.0	18	57.0	40.0	48.0	26.0
3	74.0	47.5	60.0	37.0	19	57.0	30.5	33.0	19.0
4	80.0	57.0	62.0	49.0	20	60.0	41.0	34.0	30.0
5	64.0	55.0	68.0	58.0	21	64.0	42.5	39.5	26.0
6	70.0	54.5	70.0	59.0	22	59.5	50.0	28.0	12.5
7	65.0	44.0	69.0	41.0	23	55.0	44.0	29.0	12.5
8	67.0	39.0	57.0	33.0	24	49.0	40.0	31.0	13.0
9	70.0	47.5	62.0	39.0	25	54.0	33.0	30.0	28.0
10	76.0	48.0	63.0	39.0	26	62.0	38.0	29.0	22.0
11	80.0	50.5	67.0	50.0	27	61.0	49.0	36.0	22.0
12	80.0	55.0	62.0	47.0	28	49.0	39.0	34.0	28.0
13	65.0	45.5	48.0	35.0	29	49.0	39.0	45.0	32.5
14	68.0	38.5	40.0	34.0	30	63.0	48.0	37.0	30.0
15	80.5	50.0	42.0	32.0	31	58.0	45.0	......	......
16	81.5	60.0	51.0	28.0					

Frosts (fall of 1880-'81).—October 1, 19, 25; November 1, 2, 3, 8, 9, 16.

Heavy rain-storms, May 1 to November 30, 1880.

Date.	Began.	Ended.	Amount.	Remarks.
			Inches.	
May 11	4.34 p. m	6.05 p. m	1.40	All rain-storms, between the dates named in which the amount of precipitation exceeded one inch are here given.
June 14 to 16	8.25 p. m., 14th	8.10 a. m., 16th	2.46	
July 22	6.10 a. m	4.10 p. m	1.37	
August 3 to 4	4.20 p. m., 3d	8.50 p. m., 4th	1.89	
September 6 to 7	8.35 p. m., 6th	5.00 a. m., 7th	1.34	
September 8 to 9	6.15 a. m., 8th	10.00 p. m., 9th	1.53	

Temperature and rainfall, 1880.

Month.	Average mean temperature.	Average daily rainfall.
	° *Fahr.*	*Inches.*
May, 1880	70.8	0.11
June, 1880	74.8	0.12
July, 1880	77.2	0.07
August, 1880	75.1	0.12
September, 1880	67.9	0.11
October, 1880	55.4	0.07
November, 1880	40.7	0.08

WAR DEPARTMENT, OFFICE OF CHIEF SIGNAL OFFICER,
Washington, D. C., March 16, 1881.

COMPARISON OF SEASONS 1880 AND 1881.

The crop returns for this year, and universal testimony agree that the season just past has been, over a wide area of our country, of an almost unprecedented character. A cold, backward spring and a drought of exceptional severity united to produce most unfavorable results.

The records which follow will fully sustain the general opinion and explain sufficiently the reasons of failure.

It will be observed that the average mean temperature for May and June in 1880 was 72.8°, while for the same months in 1881 it was 69.4°; also, that the total rainfall for these months was, in 1880, 6.89 inches, of which amount 5.29 inches fell in three rains, pretty evenly distributed over the two months, viz: May 11, 1.40 inches; May 22 and 23, 1.61 inches; and June 13, 2.28 inches.

On the other hand, in May and June, 1881, the total rainfall was 7.57 inches, of which 5.71 inches fell in June.

Also, it will be observed that during the three months of July, August, and September, in 1880, the mean average temperature was 73.4°, and the total rainfall 9.37 inches; the mean average temperature for these months in 1881, was 76.9°, while the total rainfall was only 4.93 inches, and of this small amount nearly half, 2.19 inches, fell in September.

The results, however, secured in the plat of sorghum planted on the grounds of the department fully justify the reputation this plant has of being able to withstand drought, although it appears necessary to this end, that the crop should secure a good start before the drought. Such, as will be seen, was the case in the experimental plat above mentioned, for, although planted early (April 29), the ground had been carefully prepared, had a good exposure to the sun, and the crop came forward rapidly, so that it was fully 2 feet high before the seed was planted for the third time in the larger fields.

In very marked contrast were the results seen upon a portion of the department ground. As has been already mentioned, a portion of the sorghum plat was plowed up through a mistake, and upon June 13, (forty-six days after the first planting), this portion was replanted with ten varieties of sorghum. But neither of these varieties attained any development, the average not being even 10 per cent. of the crop secured from the ground immediately surrounding this replanted portion, and throughout the season these ten varieties were stunted, withered, and sickly, evidently the result of the drought which followed closely upon this planting, and before a good start had been made by the plants.

On the other hand, the several varieties grown upon the field from the first planting suffered comparatively little harm, and yet, although withstanding this severe drought during July and August, the result was evident in a much lighter crop than was secured in 1880, as will be seen by the following:—

The average weight of stripped stalks per acre of thirty-eight varieties grown in 1880 was 31,409 pounds, the maximum being 50,017 and the minimum 13,839 pounds per acre.

The average weight of stripped stalks per acre of thirty-four varieties grown in 1881 was 22,524 pounds, the maximum being 33,538 and the minimum 10,750 pounds per acre.

It is interesting to consider the meteorological data of 1880 and 1881 in connection with the results shown by the tables representing the average results of analyses for these years. It will be remembered that the varieties of sorghum grown in 1880 and 1881 were mainly the same, the land upon which it was grown was the same, the mill by which the juice was expressed was the same, and care was taken to maintain it in good order. It will, however, be seen that the average percentage of juice, by weight, obtained from the stripped stalks was greater in 1881 than in 1880, that in 1881 averaging 64.02 per cent., while that in 1880 averaged only 62 per cent.

It will be seen, also, that the specific gravity of the juices from the eleventh to the eighteenth stage, inclusive (the period when the canes should be worked for sugar), differs greatly, the average specific gravity being, for this period in 1880, 1.0694, while in 1881 it was 1.0752, this showing, as is seen by the analysis, the presence of a larger quantity of sugar in these juices of 1881.

The increase in specific gravity, as will be seen, is due to the increased amounts of sugar, and since the percentage of juice is about in the inverse ratio it shows that the amount of water in the plant varies but very little, whether in seasons of rain or drought.

But the very general belief that the character of the juice undergoes great change, due to the occurrence of heavy rains, seems hardly to be supported by the facts. In fact it would be of great importance if these opinions were more generally submitted to the test of experiment. If we look over the meteorological data from the Signal Office which has just been given, we shall see that on the 10th and 11th of September, 1881, there was a rainfall of 1.73 inches, which succeeded a season of protracted drought. It would seem, then, in accordance with the generally accepted belief, that we should obtain evidence of this in a greatly increased percentage of juice; but an examination of the tables of analyses shows no appreciable change in either of the varieties.

EFFECT OF HEAVY RAINFALL AFTER LONG DROUGHT.

For the purpose of showing the effect produced, if any, in the composition of the several sorghums, due to a heavy fall of rain, the following table has been prepared, which gives the results of analyses of each variety taken before and after the heavy rainfall of September 10 and 11.

The average of the analyses of all the varieties made just before the heavy rain of September 10 and 11, viz., those made September 7, 8, and 9, also, the average of all the analyses of each variety made immediately succeeding this rainfall, viz., analyses made on September 12, 14, 15, and 17, and the results are as follows:—

Table showing effect of heavy rainfall after long drought.

Variety, Row No.	Dates of analyses.	Analyses taken just before September 10 and 11.					Analyses taken just after September 10 and 11.				
		Sucrose.	Glucose.	Solids not sugar.	Juice.	Specific gravity.	Sucrose.	Glucose.	Solids not sugar.	Juice.	Specific gravity.
		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	
1	Sept. 7, 17, and Oct. 5, 15...	18.23	.80	3.00	54.17	1.089	17.09	.86	3.64	43.83	1.088
2	Sept. 7, 17, and Oct. 5, 15...	17.41	.81	2.76	58.86	1.084	16.89	1.11	3.19	52.80	1.085
3	Sept. 7, 17, and Oct. 5, 15...	18.30	.86	1.77	63.51	1.087	16.88	1.05	2.88	53.72	1.086
4	Sept. 7, 17, and Oct. 5, 15...	19.58	.95	2.75	59.51	1.095	15.24	1.27	3.86	50.54	1.080
5	Sept. 7, 17, and Oct. 5, 15...	14.08	2.03	2.32	64.45	1.074	17.01	.49	2.98	50.46	1.086
6	Sept. 7, 17, and Oct. 5, 15...	18.38	1.48	3.95	45.14	1.098	17.69	.57	3.12	59.30	1.087
7	Sept. 7, 12, and Oct. 7, 17...	16.00	1.73	2.40	62.01	1.083	15.65	1.62	1.52	63.64	1.080
8	Sept. 7, 12, and Oct. 7, 27 ..	16.86	1.07	2.20	56.95	1.083	12.56	2.44	1.79	62.21	1.072
9	Sept. 8, 12, and Oct. 7, 17...	16.99	1.38	2.76	60.94	1.086	10.16	3.52	2.07	62.16	1.063
10	Sept. 8, 12, and Oct. 7, 17...	17.86	.83	3.39	57.69	1.089	18.18	.80	2.85	58.33	1.090
11	Sept. 8, 12, and Oct. 7, 17...	18.86	.66	3.33	54.59	1.094	17.03	1.03	2.56	59.56	1.086
12	Sept. 8, 14...................	16.12	.79	4.87	60.83	1.083	19.51	......	......	55.67	1.093
13	Sept. 8, 14...................	16.91	1.81	3.00	57.38	1.084	15.70	1.75	4.81	63.01	1.069
14	Sept. 8, 14...................	16.39	1.90	3.25	64.38	1.084	17.54	1.55	3.77	52.40	1.087
15	Sept. 8, 14...................	16.93	1.26	3.88	58.16	1.087	18.28	.77	3.94	60.10	1.087
16	Sept. 8, 14, 19, and Oct. 17..	18.81	1.26	2.97	63.87	1.098	18.61	1.14	3.10	59.00	1.091
17	Sept. 9, 14, 27, and Oct. 18..	17.38	2.29	4.94	55.77	1.093	19.20	1.54	2.61	51.49	1.092
18	Sept. 9, 14, 27, and Oct. 18..	16.46	2.58	3.98	58.05	1.086	17.79	2.85	3.55	56.79	1.089
19	Sept. 9, 14, 27, and Oct. 18..	17.20	2.00	4.67	54.48	1.089	15.79	2.06	4.52	60.35	1.084
20	Sept. 5, 14, 27, and Oct. 18..	15.35	4.30	2.89	62.78	1.089	15.95	1.96	4.23	51.53	1.084
21	Sept. 9, 14, and Oct. 3, 12...	16.02	1.53	......	62.50	1.094	18.69	1.09	......	59.77	1.090
22	Sept. 5, 15, and Oct. 3, 14...	14.40	3.00	3.06	61.71	1.080	13.96	1.93	5.05	59.53	1.075
23	Sept. 9, 15, and Oct. 3, 14...	13.00	4.71	3.65	67.62	1.081	14.23	2.04	4.14	59.04	1.081
24	Sept. 9, 15, and Oct. 3, 14...	14.27	1.51	2.51	66.00	1.073	11.31	2.64	5.03	60.07	1.064
25	Sept. 5, 15, and Oct. 3, 14...	13.45	3.26	1.92	67.92	1.073	14.23	2.55	5.43	59.56	1.076
26	Sept. 9, 15, and Oct. 3, 14...	9.80	5.18	4.40	59.53	1.073	11.14	3.73	3.82	63.11	1.070
27	Sept. 9, 15, and Oct. 3, 15...	13.05	4.16	2.28	62.78	1.077	11.65	3.82	3.68	62.24	1.070
28	Sept. 9, 15, and Oct. 3, 15...	19.25	1.48	2.41	61.06	1.089	16.73	.86	4.38	57.02	1.062
29	Sept. 9, 15, and Oct. 4, 15...	16.00	1.83	2.00	60.10	1.077	14.37	1.21	5.27	57.58	1.079
30	Sept. 9, 15, and Oct. 4, 15...	16.14	1.70	2.40	58.77	1.077	14.62	1.33	4.47	61.09	1.077
31	Sept. 9, 15...................	18.87	1.70	3.07	62.55	1.087	14.47	2.54	4.26	57.55	1.081
32	Sept. 9, 15...................	15.80	3.07	1.13	58.39	1.075	13.38	2.57	4.30	68.81	1.074
33	Sept. 9, 15...................	15.13	2.72	2.33	61.72	1.075	14.70	2.14	3.28	58.64	1.076
34	Sept. 9, 15...................	15.90	1.38	2.68	57.33	1.077	11.52	1.87	5.04	62.83	1.066
37	Sept. 7, 17...................	12.57	.99	4.19	32.36	1.073	13.61	.68	4.31	45.27	1.075
38	Sept. 7, 17...................	8.97	5.19	1.04	69.64	1.059	13.07	2.83	2.09	61.62	1.070
	Average	16.02	2.06	2.98	59.54	1.0832	15.40	1.803	3.694	57.80	1.0802

Average results of analyses of thirty-six varieties of sorghum before and after the rainfall of September 10 and 11.

		Before.	After.
Sucrose	per cent..	16.02	15.40
Glucose	do....	2.06	1.80
Solids	do....	2.98	3.69
Juice	do....	59.54	57.80
Specific gravity	....	1.083	1.080
Available sugar	per cent..	10.98	9.90

From the above it will be seen that the results of this storm, as shown in these analyses, show an average loss of—

	Per cent.
Sucrose	3.9
Glucose	12.6
Juice	2.9
Specific gravity	3.6
Available sugar	9.8

The gain in solids was 23.8 per cent.

The above results are rather surprising and certainly opposed to the view generally entertained. Without accepting them as wholly conclusive, it must be remembered that they are the results of a very large number of determinations and of a very large number of distinct varieties. If it shall hereafter be shown that such a result invariably follows a rainfall, it would appear that the explanation is, that by such rainfall a vigorous growth in the plant is excited and that the material for this rapid development of the plant is derived from the stored-up food (mainly sugar or starch) present. This would account for the loss in sugar, while the water, being simply the vehicle for transporting such food, is evaporated from the foliage more rapidly than it is absorbed by the roots.

EFFECT OF FROST UPON SORGHUM.

For the purpose of learning the effects of frost upon the sorghum, I have also taken the average of the analyses of each of the sorghums, just before the dates of the first frosts of October 6 and 11, viz., those analyses which were made September 27, and October 3, 4, 5, and 7, and those made October 14, 15, 17, and 18. The results are given in the following table.

Table showing effect of first frosts.

Just before October 6 and 11.					Just after October 6 and 11.				
Sucrose.	Glucose.	Solids.	Juice.	Specific gravity.	Sucrose.	Glucose.	Solids.	Juice.	Specific gravity.
Per ct.	Per ct.	Per ct.	Per ct.		Per ct.	Per ct.	Per ct.	Per ct.	
15.24	.87	2.76	54.28	1.078	14.32	1.16	4.60	57.90	1.078
13.56	1.39	2.15	51.18	1.073	14.12	1.18	4.14	57.93	1.075
16.32	1.08	2.74	44.54	1.087	16.59	1.09	5.11	55.81	1.088
11.85	1.11	3.05	55.10	1.068	16.24	1.27	4.20	55.80	1.082
12.58	.70	2.40	51.31	1.068	14.65	.40	5.03	57.44	1.078
15.36	.98	2.88	58.06	1.082	13.97	3.28	4.33	52.07	1.084
14.77	1.31	3.65	50.89	1.082	11.99	1.16	3.73	58.13	1.069
17.22	.95	2.94	48.46	....	13.88	2.44	3.97	55.23	1.084
12.54	2.12	2.58	61.19	1.070	13.24	1.85	3.45	58.09	1.076
17.38	.51	4.12	58.02	1.090	16.30	.40	3.80	54.60	1.085
16.89	.42	3.38	57.25	1.085	16.13	.59	4.87	52.91	1.088
17.40	.78	....	55.58	1.089	13.90	1.78	4.44	47.38	1.081
16.57	1.52	3.14	55.84	1.083	14.72	1.64	2.50	58.99	1.079
18.15	1.39	4.40	55.09	1.094	13.55	1.50	3.59	56.95	1.078
16.68	1.56	....	49.29	1.089	14.39	1.73	2.93	58.07	1.081
14.14	2.60	3.07	46.29	1.080	15.25	1.96	2.01	58.51	1.082
16.10	.94	4.20	53.87	1.085	15.60	1.20	3.47	58.75	1.085
15.78	1.26	4.01	57.97	1.083	12.41	2.57	1.81	65.80	1.069
15.77	1.72	4.23	55.99	1.084	12.44	3.02	2.63	60.84	1.075

Table showing effect of first frosts—Continued.

	Just before October 6 and 11.					Just after October 6 and 11.				
	Sucrose.	Glucose.	Solids.	Juice.	Specific gravity.	Sucrose.	Glucose.	Solids.	Juice.	Specific gravity.
	15.91	1.27	3.66	51.72	1.082	9.45	1.58	2.31	62.71	1.053
	14.55	2.31	3.11	57.28	1.079	4.64	4.77	2.61	67.31	1.048
	16.22	1.66	4.17	57.98	1.088	10.19	2.46	3.28	56.11	1.067
	11.70	4.14	2.74	63.72	1.071	6.50	3.98	2.97	59.73	1.052
	16.35	1.20	4.15	56.77	1.085	7.27	1.07	3.14	64.03	1.045
	14.86	1.50	3.27	52.94	1.082	12.15	1.92	1.96	60.39	1.071
	13.50	1.43	3.34	....	1.078	11.69	1.28	4.00	59.51	1.066
Av'ge.	15.28	1.41	3.37	54.82	1.0814	12.91	1.82	3.49	58.09	1.0738

Average results of analyses of thirty-six varieties of sorghum before and after the frosts of October 6 *and* 11.

	Before.	After.
Sucrose .... per cent..	15.28	12.91
Glucose .... do.....	1.41	1.82
Solids .... do.....	3.37	3.49
Juice .... do.....	54.82	58.09
Specific gravity	1.081	1.074
Available sugar .... per cent..	10.50	7.6

From the above averages it will be seen that the results of these frosts show an average loss of—

	Per cent.
Sucrose	15.5
Specific gravity	8.6
Available sugar	27.6

And a gain of—

	Per cent.
Glucose	29.1
Solids	3.6
Juice	6.0

The above results accord with the general belief as to the injurious effects of frost upon the cane. It would appear from the increase in glucose and decrease in sucrose that the effects of frost were to produce an inversion of the sugar present in the juices of the plant.

If we consider the average results produced in a few of the different varieties of cane, viz, Mastodon No. 24, Honduras No. 25, Sugar Cane No. 26, Wallis's Hybrid No. 27, White Imphee No. 28, and White Mammoth No. 7, for example, we shall find the effect even more marked. For purpose of comparison I have given the average results of analyses of the above varieties by themselves, and also the average results of several other varieties by themselves, viz, Early Amber No. 1, Early Golden No. 2, White Liberian Nos. 3 and 4, Black-Top No 5, African No. 6, Regular Sorgho No. 9, Link's Hybrid Nos. 10 and 11.

Average results of analyses of Nos. 7, 24, 25, 26, 27, 28, *made just before and just after the frosts of October* 6 *and* 11.

	Before.	After.
Sucrose .... per cent..	14.92	8.34
Glucose .... do.....	1.98	2.50
Solids .... do.....	3.58	3.01
Juice .... do.....	57.89	61.34
Specific gravity	1.081	1.056
Available sugar .... per cent..	9.36	2.83

Average results of analyses of Nos. 1, 2, 3, 4, 5, 6, 9, 10, 11, *made just before and just after the frosts of October* 6 *and* 11.

	Before.	After.
Sucrose .... per cent..	14.64	15.06
Glucose .... do....	1.02	1.25
Solids .... do....	2.90	4.39
Juice .... do....	54.55	55.83
Specific gravity	1.078	1.082
Available sugar .... per cent..	10.72	9.42

From the above it will be seen that the effects of these frosts were far more disastrous upon the first group of sorghums selected than upon the last group, for, arranging the results side by side, this difference in effect produced is readily compared, thus:

	First group.		Second group.	
Sucrose .... per cent..	Loss	44.1	Gain	2.9
Glucose .... do....	Gain	26.3	Gain	22.5
Solids .... do....	Loss	15.9	Gain	51.4
Juice .... do....	Gain	6.0	Gain	2.3
Specific gravity	Loss	30.9	Gain	5.1
Available sugar .... per cent..	Loss	09.8	Loss	12.1

As will be seen from the above statement, there is practically little effect shown by the frost upon the several varieties of sorghum in the second group. The percentage of increase in glucose and solids is in fact not a very large actual increase, while the percentage of sucrose in the juice is slightly more.

It is more than probable that the difference in the effects of the frost upon the two groups is due to the fact that in the case of the second group the different varieties of sorghum were those of early maturity, and this will be seen by reference to the tables of analyses of these varieties, which will show that for a long period these varieties had reached their maximum content of sugar, and in fact had begun to fall off a little; while, as will be seen by reference to the tables, the members of the first group were of the late varieties, and their full development had not yet been attained, for their content of sucrose was and had been gradually increasing. It is therefore probable that while the plant is in its immature condition, the functions of growth and the elaboration of its sugar in vigorous action, it is far more susceptible to the action of frost than after full maturity has been attained. Should this prove to be the case it would explain the injurious action of frost upon the sugar cane of Louisiana, which, owing to the long period necessary for its full development, can never reach that condition of maturity which would render it comparatively safe.

The above results will enable us to explain the very conflicting testimony of sorghum-growers as to the effects of frost upon their crops, many having experienced no evil results, while others have found the effects of frost most disastrous. At least these results will be of value in guarding us from drawing too hasty conclusions, since, as will be seen, a reasonable support is afforded in the above data for either view, and it would seem wise to withhold conclusions until more facts are accumulated.

AVAILABLE SUGAR—MEANING OF THE TERM.

We have already explained the meaning of this term, but its importance is such that a fuller discussion of the conditions which tend to increase or diminish the amount should be had, since although the economical production of molasses of a good quality from sorghum would save us an annual importation of several million dollars' worth, of itself an amount fully justifying any reasonable expense of investigation looking to this production; yet the present annual importation of sugar, which steadily increases in amount, makes this matter of sugar production of extreme importance.

VALUE OF THE SUGAR AND MOLASSES IMPORTED IN 1879.

In 1879 the sugar and molasses imported reached in round numbers the amount of $76,500,000, one-eighth of which was for molasses, a sum requiring considerably more than the aggregate production of gold and silver of our mines, which in 1880 was of gold $36,000,000 and of silver $39,200,000, a total of $75,200,000, or $1,300,000 less than sufficient to pay for the sugar imported the previous year.

GENERAL RESULTS OF ANALYSES BEARING UPON THE QUESTION OF AVAILABLE SUGAR.

By reference to the table giving the general results of all the analyses of the several varieties of sorghum in 1879, 1880, and 1881, the aggregate number of analyses being 4,042 and the varieties analyzed being about 40, these results having been obtained from as many distinct varieties by so large a number of separate analyses made in successive years, the general conclusion reached appears established beyond question.

It will be seen that during the early stages of development of these plants, up to and including the sixth stage, the available sugar is given as a minus quantity, *i. e.*, the amount of sucrose in the juice is less than the sum of the glucose and other solids. It will also be seen that in the seventh stage the available sugar is practically none, being only .13 per cent., and this stage represents the period when the seed is in the milky state. It is then obviously absurd to expect to obtain any sugar by working up the crop until it has advanced beyond this condition toward maturity.

It will also be observed in the table that during these early stages the amount of this minus available sugar remains nearly the same, the average for the first five stages being —3.22 per cent.; and also that the available sugar after it first appears rapidly increases in quantity, and remains practically constant through the several subsequent stages; and in this it agrees, as will be seen, with the development of the sucrose, which, at a certain period, is very rapid, and afterward nearly constant through the season, while, as has been remarked, the sum of the glucose and solids is nearly the same throughout.

DANGER OF MIXING IMMATURE WITH MATURE CANE IN WORKING.

It is of greatest practical importance also to consider the effect of mixing immature with mature canes in the working. If, for example, a ton of sorghum in the tenth stage was mixed with an equal quantity in the third stage, and the mixed juices together boiled to a sirup, it is doubtful whether any sugar would be obtained, for, as will be seen, the first lot would yield a juice having 4.49 per cent. of available sugar, the second lot of juice would have —3.24 per cent., and the mixed juice would, of course, have but .62 per cent. available, so small a quantity as to be practically valueless. It is, then, to be remembered that for the purpose of sugar-making every unripe cane allowed to go to the mill is not only worthless in itself, but far *worse than worthless*, since it causes the loss of sugar otherwise available.

This fact will more clearly appear if the necessary calculations are given of the results. Supposing that the mill gives 60 per cent. of the weight of stalks in juice; we should then have 1,200 pounds of juice from each ton of stalks, and the former would give 4.49 per cent. of sugar, or 53.88 pounds, while the latter would give —3.24, or minus 38.88 pounds, the difference being 15 pounds of sugar from the two tons of stalks, equal to .625 per cent. of 2,400 pounds of juice.

We thus see that by mixing in the immature canes we really obtain only about one-fourth the sugar which the one ton of good cane would have yielded alone.

The above facts are practically understood by the sugar-planters of Cuba and Louisiana, for they are careful to cut off and leave upon the field the upper and immature portion of the sugar cane, knowing by experience that by sending it to the mill it results in actual loss in their product of sugar.

That their practice is entirely justified by the results of analysis will be seen by reference to the table below, which represents the average results in each case of four analyses of the juices from the butt, the middle, and the top of three varieties of sugar cane grown in Louisiana.

Table showing relative value of different parts of sugar-cane stalk.

	Butt.	Middle.	Top.
Sucrose....per cent..	15.36	12.95	3.21
Glucose....do......	.75	1.42	3.68
Solids....do......	.24	.68	2.23
Available sugar....do......	14.37	10.85	—2.70
Specific gravity....	1.068	1.061	1.038

From the above results there would seem to be in the immature sugar-cane top a close resemblance to the immature stalk of sorghum, and yet the analogy ceases so soon as the sorghums have attained full maturity, for, as the results of very many analyses show, there is practically no difference in the juice from the upper or lower half of the sorghum stalks.

This difference is probably due to the fact that, owing to the short season, comparatively, it is impossible for the sugar cane to reach, even in Louisiana, a condition of full maturity.

DANGER FROM SUCKERS.

It is important also to remember that, owing to the tendency of sorghum to send up suckers from its roots from time to time during the season, there is the liability of having in the crop canes of every stage of development, and the injurious effect already shown is sure to result. It is therefore necessary, in order to secure the best results in the production of sugar, to see to it that either the growth of these suckers be prevented by removing them from time to time during the season, or that they be thrown aside when the crop is harvested as worthless except for the production of sirup.

To demonstrate this point, the plat of sorghum, as has been already described, was divided into two nearly equal parts, and from the one portion the suckers were removed as fast as they appeared, while they were allowed to grow upon the other portion.

The difference in the results of the above treatment is manifest in the following table, which gives the weight of crop and the analyses of the juices from the suckered and unsuckered canes:

Comparative results from suckered and unsuckered sorghum.

Number.	Weight of stripped stalks per acre, pounds.		Per cent. of juice.		Specific gravity of juice.		Per cent. glucose in juice.		Per cent. sucrose in juice.		Per cent. solids in juice.		Per cent. available sucrose in juice.	
	Suckered.	Not suckered.	Suckered.	Not suckered.	Suckered.	Not suckered.	Suckered.	Not suckered.	Suckered.	Not suckered.	Suckered.	Not suckered.	Suckered.	Not suckered.
1	21, 074	24, 757	45. 4	43. 4	1. 087	1. 088	1. 38	2. 52	16. 06	15. 56	3. 81	0. 99	10. 87	12. 05
2	23, 201	34, 667	48. 3	46. 3	1. 088	1. 085	1. 37	2. 07	15. 93	16. 52	3. 93	1. 69	10. 63	12. 76
3	17, 006	26, 426	43. 1	48. 6	1. 083	1. 080	1. 37	1. 62	16. 03	14. 62	3. 46	4. 45	11. 20	9. 61
4	15, 329	29, 512	47. 5	50. 7	1. 098	1. 079	1. 27	1. 67	15. 81	13. 60	4. 27	4. 55	10. 27	7. 38
5	22, 848	33, 603	50. 5	......	1. 074	1. 070	1. 22	3. 50	13. 10	9. 76	3. 78	6. 17	8. 10	0. 09
6	16, 327	21, 110	46. 3	52. 5	1. 074	1. 067	1. 97	2. 87	12. 89	10. 29	3. 11	5. 32	7. 81	2. 22
7	33, 333	27, 373	50. 9	49. 3	1. 078	1. 074	1. 35	3. 79	13. 96	11. 76	2. 91	4. 46	9. 70	3. 51
8	17, 852	18, 599	48. 1	50. 9	1. 075	1. 069	1. 72	4. 73	12. 83	10. 06	2. 93	3. 49	8. 18	1. 84
9	21, 383	21, 194	51. 6	51. 0	1. 071	1. 056	2. 91	3. 59	11. 08	7. 33	2. 72	4. 79	5. 45	−1. 05
10	33, 041	28, 936	49. 8	51. 1	1. 086	1. 067	0. 80	1. 86	16. 29	12. 08	......	2. 64	15. 49	7. 58
11	29, 766	29, 702	41. 0	52. 7	1. 087	1. 062	0. 66	1. 33	16. 78	13. 06	3. 02	2. 03	13. 10	9. 10
12	32, 103	30, 161	48. 8	53. 0	1. 088	1. 066	0. 74	1. 46	16. 76	11. 94	3. 18	2. 78	12. 84	7. 70
13	18, 045	22, 080	51. 5	56. 2	1. 076	1. 050	2. 39	4. 07	12. 62	6. 35	2. 97	2. 29	7. 26	−0. 01
14	20, 461	21, 252	46. 9	48. 8	1. 074	1. 065	3. 16	2. 41	12. 58	10. 92	2. 32	5. 35	7. 10	3. 16
15	20, 643	21. 856	53. 1	49. 9	1. 074	1. 075	1. 74	1. 45	13. 82	14. 63	2. 17	7. 21	9. 91	5. 97
16	24, 486	29, 294	45. 2	45. 7	1. 079	1. 068	1. 71	1. 90	14. 21	12. 67	2. 98	2. 75	9. 52	8. 03
17	30, 634	31, 079	53. 4	44. 1	1. 078	1. 065	1. 92	3. 69	13. 92	10. 57	2. 38	2. 12	[illegible]	4. 76
18	20, 447	23, 584	48. 2	39. 8	1. 081	1. 064	2. 48	3. 38	14. 12	13. 57	2. 41	......	[illegible]	10. 19
19	26, 252	30, 831	50. 0	42. 7	1. 078	1. 067	2. 27	3. 35	13. 81	10. 96	2. 28	2. 42	9. 26	5. 18
20	21, 915	26, 244	47. 3	41. 3	1. 075	1. 063	2. 84	3. 80	12. 10	9. 94	2. 31	2. 72	6. 95	3. 42
21	30, 683	33, 707	50. 0	44. 2	1. 077	1. 068	1. 33	1. 87	14. 11	11. 67	2. 75	3. 54	10. 03	6. 26
22	27, 979	30, 934	50. 2	44. 6	1. 071	1. 052	2. 62	3. 08	11. 48	......	2. 30	9. 90	6. 56	......
23	27, 700	29, 040	50. 2	44. 6	1. 071	1. 059	5. 07	4. 24	9. 27	8. 18	2. 23	3. 16	1. 97	0. 78
24	33, 538	29, 941	52. 9	51. 3	1. 062	1. 051	2. 31	3. 09	10. 30	8. 24	3. 14	4. 22	5. 88	0. 93
25	24, 489	34, 447	56. 5	54. 5	1. 057	1. 062	5. 02	5. 06	7. 25	8. 47	1. 73	3. 74	0. 50	−0. 33
26	17, 215	19, 677	49. 8	51. 4	1. 063	1. 053	3. 52	3. 49	9. 72	6. 15	1. 90	3. 27	4. 30	−0. 61
27	17. 184	26, 036	55. 0	51. 6	1. 056	1. 053	5. 00	4. 27	7. 19	5. 68	1. 87	2. 96	0. 23	−1. 55
28	19, 382	18, 525	50. 2	54. 6	1. 068	1. 041	1. 55	1. 62	13. 52	5. 45	2. 06	3. 01	9. 91	0. 83
29	10, 750	18, 125	49. 1	55. 8	1. 063	1. 044	2. 43	3. 35	11. 21	3. 98	2. 44	3. 30	6. 34	0. 82
30	19, 446	24, 058	48. 8	51. 9	1. 066	1. 070	1. 52	1. 34	11. 92	11. 38	2. 83	3. 82	7. 57	6. 23
31	24, 418	23, 582	47. 2	52. 4	1. 069	1. 072	1. 95	4. 37	15. 57	11. 03	3. 66	1. 85	9. 96	4. 81
32	16, 128	12, 717	53. 1	50. 0	1. 070	1. 055	2. 86	3. 63	12. 27	7. 58	2. 86	2. 06	6. 55	1. 89
33	13, 800	17, 099	37. 9	49. 9	1. 082	1. 070	1. 84	3. 75	14. 70	11. 26	3. 83	1. 99	9. 53	5. 52
34	16, 977	19, 877	46. 2	52. 1	1. 078	1. 077	1. 56	1. 91	14. 82	13. 96	3. 33	2. 56	9. 93	9. 49
Total	765, 826	870, 031	1, 664. 0	1, 646. 9	36. 557	36. 007	72. 97	100. 33	447. 83	348. 21	102. 37	118. 20	274. 85	148. 33
Average	22, 525	22, 589	48. 9	49. 9	1. 075	1. 059	2. 14	2. 95	13. 17	10. 55	3. 10	3. 58	8. 08	4. 49

From the preceding table it will be seen that while the average crop was the same from the suckered and unsuckered plats, and the percentage of juice also practically the same, the composition of the juice varied very widely, and in every particular was strongly in favor of the suckered stalks, so far as the production of sugar is concerned.

The average results of the thirty-four varieties show the relative composition of juices to be as follows:

	Suckered.	Unsuckered.	Ratio.
Specific gravity	1.075	1.059	100 : 78.7
Sucrose ....per cent..	13.17	10.55	100 : 80.1
Glucose ....do....	2.14	2.95	100 : 137.9
Solids ....do....	3.10	3.58	100 : 115.5
Available sugar ....do....	8.08	4.49	100 : 55.6
Stripped stalks	22,525	22,589	100 : 100.3
Juice ....per cent..	48.9	49.9	100 : 102.0

It will be seen that, although there is a much greater amount of glucose and solids in the juice of the unsuckered canes, the specific gravity is less, and the sucrose is a fifth less, while the available sugar is only 55.6 per cent. of the amount present in the juice of the suckered stalks.

By reference to the table it will be seen that several of the varieties show no difference between the suckered and unsuckered portions, while in fact some of them, as Nos. 1, 2, 18, show an amount of available sugar greatest in the juice of the unsuckered canes. The explanation of this is probably that, owing to the fact that these varieties had so long reached maturity, while the more advanced suckered canes had begun to fall off in their content of sugar, the unsuckered portions of the cane were largely composed of suckers which had themselves had time to reach their complete maturity, and consequently they had brought up the average of the juice rather than to have lowered it.

It is also to be observed that in the case of several of these varieties we have results fairly comparable with what might be expected upon a large scale, for although, as has been already stated, the analyses made during the season in the laboratory were of stalks taken from the suckered portion of each variety, and although exactly one-sixth part by actual weight on an average was taken from each variety, and that whenever a stalk was cut down there would spring up suckers in its place, which were included in the final cutting, generally, as we have seen, with the effect to lower the average sugar content, it is yet true that many of these, as we may term them, culled rows gave averages in sugar fairly comparable with the average results from our Louisiana sugar cane.

The average of Nos. 1, 2, 3, 4, 10, 11, 12, in available sugar, is 12.53 per cent. of the juice. The average crop of stripped stalks per acre actually obtained of these seven varieties was 26,667 pounds.

A good mill would give 60 per cent. of juice, or 16,000 pounds, and 12.53 per cent. of this amount would give 2,005 pounds of sugar per acre as the average product to be expected from the results obtained.

METHOD OF ANALYSIS.

It is obviously of the first importance that the results of analyses given should have been obtained by reliable methods. The analytical work this year has been performed practically by the same methods employed in 1879 and 1880, and every precaution has been taken to guard against error and to control the results.

In the first place, it may be remembered that each assistant, in the routine work assigned him, was necessarily free from all prejudice as to what result he was to expect, for each sample of juice, sirup, or cane examined was known only by a number, and this was known only to one who himself performed no analytical work.

Every questionable result was at once repeated, and many duplicate samples of juice, under different numbers, and without the knowledge of any of those engaged in the analysis, were from time to time analyzed.

Each new lot of either of the reagents employed in analysis was carefully tested, and indeed nothing was omitted which would tend to accuracy in work.

The following table shows the the results of many duplicate analyses of juices made during the season. It will be seen that the agreement is generally very close, with very few exceptions.

Those familiar with chemical methods, and considering the vast amount of work actually performed in these analyses, are aware that absolute accuracy is not to be expected, but whatever errors there may be are certainly within very narrow limits, and the general results furnished in the foregoing analyses may be confidently relied upon as being practically near approximations to the truth.

List of duplicate test made in sorghum analysis, 1881.

Number of analysis.	Per cent. of sucrose by titration.	Per cent. of sucrose by polariscope.	Per cent. of glucose by titration.	Specific gravity of juice.	Per cent. of solids not sugar.
351	7.38	7.02	2.68	1.045	2.47
359	7.12	7.25	2.75	1.047	2.54
371	8.76?	....	2.61	1.085	2.04
378	10.67	....	2.61	1.080	2.46
385	16.35	15.48	0.12	1.046	—1.43
	16.20				
412	11.43	11.95	2.05	1.064	2.26
437	11.75	11.06	2.17	1.063	1.84
413	9.55	9.00	2.95	1.061	1.91
436	9.27	8.94	4.21	1.060	2.00
415	5.49	4.95	2.73	1.041	2.06
434	5.84	6.00	2.91	1.040	2.06
416	7.21	6.58	2.73	1.049	2.23
439	7.05	6.59	2.84	1.047	4.71
417	7.69	7.26	2.06	1.047	2.26
432	7.28	7.26	2.34	1.047	2.33
424	5.84	....	6.17	1.054	2.77
438	5.88	5.86	6.22	1.054	1.75
426	5.62	....	3.19	1.044	2.49
431	5.21	5.06	3.49	1.043	2.42
427	4.14	3.80	5.44	1.044	2.34
440	3.98	3.74	5.77	1.044	2.06
429	4.11	2.72	5.16	1.039	1.46
435	3.29	2.80	5.47	1.039	1.40
430	2.03	1.29	5.93	1.036	1.59
433	1.72	1.27	6.03	1.036	1.95
441	9.02	9.18	3.02	1.058	2.75
452	9.49	9.21	2.52	1.057	2.37
443	4.00	7.25	2.38	1.047	5.96
445	7.32	7.21	2.42	1.047	2.67
446	6.68	6.09	2.61	1.046	2.75
455	6.16	6.18	2.69	1.046	3.01
447	3.84	....	5.95	1.045	2.41
451	4.04	....	5.86	1.045	1.34
449	3.13	2.76	5.36	1.040	2.71
457	3.15	2.85	5.44	1.040	2.79
466	7.02	6.95	2.62	1.048	4.96
468	7.01	....	2.55	1.049	6.79
467	5.72	....	1.59	1.041	4.45
461	5.49	5.31	1.50	1.041	4.96
470	3.03	2.87	3.51	1.034	2.90
463	3.01	2.93	3.39	1.034	4.63
475	5.64	4.32	2.34	1.043	4.29
462	5.94	4.40	2.25	1.043	4.27
472	14.53	14.15	.08	1.044	—4.20
	14.16				

List of duplicate test made in sorghum analysis, 1881—**Continued.**

Number of analysis.	Per cent. of sucrose by titration.	Per cent. of sucrose by polariscope.	Per cent. of glucose by titration.	Specific gravity of juice.	Per cent. of solids not sugar.
486	5.84	....	3.56	1.045	2.10
491	5.17	....	3.65	1.043	2.93
490	5.92	5.71	2.18	1.039	2.23
489	5.64	....	2.11	1.039	2.07
493	4.58	4.15	2.53	1.037	2.72
485	4.92	4.25	2.52	1.038	2.90
496	8.51	....	2.66	1.041	2.33
487	4.29	3.75	2.66	1.040	2.63
500	6.27	5.27	3.24	1.045	2.21
488	5.81	5.36	3.16	1.046	2.12
583	9.45	9.69	1.42	1.055	4.53
586	9.47	8.84	1.39	1.055	4.93
584	4.68	4.23	2.64	1.039	2.55
587	4.36	4.24	2.70	1.040	2.61
590	7.58	7.02	2.68	1.049	1.65
596	8.03	6.98	2.86	1.049	1.16
591	7.66	7.02	2.77	1.050	1.70
618	11.41	12.21	4.03	1.069	1.08
620	12.06	11.22	4.15	1.069	0.85
619	12.70	10.67	2.73	1.064	0.08
609	12.25	10.65	2.70	1.064	1.55
631	4.43	4.01	5.14	1.044	2.49
634	4.19	3.72	5.21	1.043	2.58
637	3.84	3.02	6.24	1.045	2.31
633	3.88	3.11	6.25	1.044	1.74
665	6.90	7.00	2.20	1.049	3.05
662	7.32	7.30	2.39	1.049	—1.58
670	10.23	9.60	3.88	1.054	—0.78
673	9.55	8.93	2.17	1.054	2.74
678	15.05	14.67	1.04	1.079	2.72
680	15.15	14.82	1.10	1.079	2.48
683	12.44	12.14	1.98	1.069	2.55
679	12.22	12.12	1.98	1.069	2.54
765	12.79	12.19	2.06	1.071	2.42
773	12.46	....	2.09	1.071	2.76
771	12.07	10.83	1.39	1.064	1.58
766	10.98	10.27	1.30	1.064	2.90
791	10.15	8.88	4.29	1.062	1.69
788	9.64	8.88	4.47	1.062	1.90
795	12.15	9.73	3.09	1.065	0.51
798	10.55	9.72	3.67	1.065	2.21
804	5.29	3.09	2.28	1.040	2.33
811	5.16	4.73	2.42	1.040	2.51
808	8.42	....	4.42	1.055	2.04
810	8.26	7.90	4.52	1.058	2.15
818	9.20	8.56	1.50	1.050	1.81
824	13.60	8.69	1.46	1.049	—2.48
826	11.45	....	1.39	1.078	0.02
828	13.43	....	1.21	1.077	4.81
834	15.73	15.14	1.69	1.082	2.54
836	15.97	15.31	1.69	1.082	2.64
833	15.62	15.53	1.69	1.082	2.65
842	16.07	....	1.78	1.083	2.69
831	23.66	23.15	.19	1.074	—0.39
	23.15				
847	11.62	11.51	2.36	1.062	1.98
857	11.74	11.63	2.36	1.062	1.90
849	11.56	10.77	1.82	1.060	2.54
861	11.48	10.76	1.53	1.061	2.07
851	13.83	13.15	1.21	1.078	3.14
856	14.28	....	1.21	1.077	2.76
879	6.10	6.37	3.49	1.049	4.18
890	6.48	6.49	3.49	1.049	3.70
883	7.44	6.63	2.33	1.044	2.55
891	7.28	6.66	2.39	1.048	2.41
896	14.12	13.60	2.02	1.078	1.94
906	14.03	....	1.96	1.080	3.87
901	15.29	14.21	1.56	1.076	3.42
906	15.07	14.19	1.56	1.076	2.60
948	16.06	....	1.87	1.078	2.61
952	15.40	15.07	1.89	1.078	2.21
959	5.20	5.26	1.55	1.042	3.99
958	5.42	....	1.61	1.042	3.62
964	16.90	....	1.54	1.067	3.21

List of duplicate test made in sorghum analysis, 1881—Continued.

Number of analysis.	Per cent. of sucrose by titration.	Per cent. of sucrose by polariscope.	Per cent. of glucose by titration.	Specific gravity of juice.	Per cent. of solids not sugar.
[illegible]	16.96	....	1.67	1.085	3.02
[illegible]	12.57	....	1.76	1.061	1.03
[illegible]	11.17	10.49	2.46	1.061	1.63
968	13.98	15.26	3.23	1.075	2.89
1001	13.66	12.97	....	1.074	1.90
074	15.80	14.69	1.21	1.078	2.01
1002	15.96	....	1.47	1.077	2.30
1012	15.67	....	1.70	1.085	6.73
1017	16.53	....	1.27	1.083	6.76
1016	9.65	8.86	5.57	1.065	5.06
1018	9.42	9.02	5.46	1.066	5.76
1019	18.05	17.10	1.21	1.089	2.28
1047	17.20	....	1.55	1.088	3.67
1030	13.86	....	3.00	1.080	3.14
1048	14.40	....	3.00	1.080	3.06
1065	16.00	15.33	1.73	1.063	2.40
1067	15.64	15.14	1.78	1.063	2.80
1050	11.77	7.41	5.19	1.059	1.92
1068	8.97	7.34	5.19	1.059	1.04
1091	9.54	9.03	4.93	1.065	3.41
1101	9.79	8.23	5.28	1.065	2.11
1090	14.27	12.92	1.51	1.073	2.51
1102	14.60	13.78	1.51	1.073	3.46

THE ANALYTICAL PROCESSES FOR THE EXAMINATION OF THE CANES.

One or more stalks of the variety of sorghum to be examined were selected in the experimental field, and after recording the stage of development and general appearance of the canes a number was affixed by which they could be distinguished during the remainder of the examination. After being cut and brought to the laboratory, the length of the stalk from butt to the extremity of the head, its entire weight, and diameter at the butt were taken. It was then stripped and topped, as in the usual way of preparation for the mill, and again weighed. The "stripped stalk" was then expressed in a three-roll mill, and the juice collected in a weighed flask and weighed to determine "per cent. of juice" in the stripped stalk. The specific gravity was determined with a piknometer, after an interval of an hour to allow the escape of air bubbles and the subsidence of suspended starch. For the determination of the "total solids" in the juice $2^{cm3.}$ were accurately measured into a weighed porcelain dish 6 to $7^{cm.}$ wide and 1.5 to $2^{cm.}$ deep, the bottom of which was previously covered with coarse sand to a depth of $.75^{cm.}$ to insure complete desiccation. After twelve to fourteen hours' drying at 85° to 90° C., there was no further loss of water. The weight of the residue in grams divided by twice the specific gravity gave the per cent. of "total solids."

For the determination of glucose and sucrose, $100^{cm3.}$ of the juice were taken and defecated by the addition of $25^{cm3.}$ of solution of basic acetate of lead in water. The filtrate from the lead precipitate, which was perfectly clear, was in many instances polarized and then devoted to the methods of volumetric analysis. Owing to the degree of dilution, every $10^{cm3.}$ of filtrate represented $8^{cm3.}$ of juice.

For the determination of glucose $10^{cm3.}$ of the filtrate were taken; for sucrose, $5^{cm3.}$. The portion for glucose was diluted with about 50 to $75^{cm3.}$

of water and about the same amount of Fehling's solution added. The porcelain dish containing the whole was placed upon a water bath kept at such a temperature by steam that the liquid in the dish rose to about 75° C., but no higher. After an interval of thirty minutes the dish was removed and allowed to cool. The portion for sucrose was diluted with about 100$^{cm^3}$. of water, 5$^{cm^3}$. of hydrochloric acid (sp. gr. 1.05) added, and the mixture heated in a porcelain dish on a steam bath for a half hour, the temperature not rising above 90° C. The inversion being complete, an excess of Fehling's solution was added, depending in amount on the maturity of the cane, and the liquid allowed to remain thirty minutes longer on the bath, after which it was removed. When the suboxide of copper had completely settled, in the case of both sucrose and glucose, the supernatant liquid was decanted into a beaker placed in front of each dish, and hot water was poured over the suboxide. This process was repeated, pouring the first liquid decanted into a second beaker, and so on until it could be poured away free from any oxide, and the original dish was nearly free from alkali. All the wash waters were then passed in order through a filter, taking care to bring as little as possible of the suboxide upon the filter.

The suboxide on the filter and in the beakers was dissolved in an acid solution of ferric sulphate, free from nitric acid and ferrous salt, or more conveniently in an acid solution of ammonia ferric alum (which is more easily obtained free from impurities), and poured upon the suboxide in the original dish. All the copper suboxide being dissolved, it is brought into a liter flask, diluted with water to *about* 500$^{cm^3}$. and acidified strongly with sulphuric acid. It is then ready to be titrated in the usual manner for the amount of reduced iron, the number of $^{cm^3}$. of permanganate used giving easily the weight of glucose represented by the suboxide of copper, as shown in our report for 1879, p. 66.

In order to determine what errors there may have been in estimating glucose and sucrose by this method, the following experiments were carried out. Every portion of Fehling solution used was heated by itself in the steam bath for an hour to determine if it remained unreduced in absence of sugar. In all cases it was quite unchanged. Several solutions of dry granulated sugar containing about .10 per cent. of impurities were made of such a strength that every 5$^{cm^3}$. contained .5000 gram of pure sucrose, or, on inversion, .5263 of invert sugar.

Of solution No. 1, four portions were measured out of 5$^{cm^3}$. each and submitted to the usual course of analyses, with the following result:

Experiment.	Titration.	Glucose found.	Glucose used.	Per cent. found.
No. 1	104.2	.5210	.5263	98.99
No. 2	103.4	.5170	.5263	98.24
No. 3	104.4	.5220	.5263	99.18
No. 4	104.5	.5225	.5263	99.28
Average	....	....	....	98.93

The specific gravity was found by the piknometer to be 1.034. The solution contained, therefore, 9.67 per cent. of sugar. By titration we find 9.57 per cent. of sugar, and polarization of the solution gave 9.63 per cent. of sucrose.

Of the solution No. 2, nine portions were taken of 5^{cm^3} each, to six of which (Nos. 1–6) 5^{cm^3} of the usual dilute acid were added, and to the remaining three, 10^{cm^3}; otherwise the usual course of analysis was pursued. The entire lot was carried through simultaneously on the same steam bath. The results were as follows:

Experiment.	C^{cm} of permanganate.	Glucose found.	Per cent. of original.	Per cent. sucrose in solution.
No. 1	104.5	.5225	99.28	9.60
No. 2	105.3	.5265	100.10	9.67
No. 3	106.6	.5330	101.36	9.79
No. 4	108.3	.5415	102.88	9.95
No. 5	107.4	.5370	102.02	9.86
No. 6	108.1	.5405	102.70	9.93
No. 7	104.6	.5230	99.38	9.61
No. 8	104.4	.5220	99.18	9.59
No. 9	105.2	.5260	99.94	9.66
Average	....	....	100.74	9.74

The specific gravity was found to be 1.034 and the per cent. of sugar in the solution was therefore: By calculation, 9.67; by titration, 9.74. An estimation of total solids gave 9.70 per cent. The addition of the larger amount of acid apparently had the effect of lowering the per cent. of sucrose found. In no case was the error in the final result sufficiently large to be of account in work on such a large scale.

Fifteen portions of 5^{cm^3} each were taken from solution No. 3. Its specific gravity was 1.035, and the per cent. of sucrose 9.66.

Submitted to analysis in the usual way, the results were:

Experiment.	C^{cm} of permanganate at .005 glucose.	Glucose found.	Sucrose found.	Per cent. of sucrose.
No. 1	107.0	.5350	.5082	9.82
No. 2	108.0	.5400	.5130	9.91
No. 3	106.0	.5300	.5036	9.73
No. 4	106.0	.5300	.5035	9.73
No. 5	107.0	.5350	.5082	9.82
No. 6	106.0	.5300	.5035	9.73
No. 7	108.7	.5435	.5163	9.98
No. 8	106.8	.5340	.5073	9.80
No. 9	106.3	.5315	.5049	9.76
No. 10	106.5	.5325	.5059	9.78
No. 11	106.8	.5340	.5073	9.80
No. 12	106.3	.5315	.5049	9.76
No. 13	106.0	.5300	.5035	9.73
No. 14	104.9	.5245	.4983	9.63
No. 15	105.3	.5265	.5002	9.66
Average	....	....	....	9.77

By calculation 9.66
By titration 9.77

The results of thirty determinations may be stated as follows:

	Per cent.
Sugar solution containing	9.67
No. 1. Four determinations, by titration (average)	9.57
No. 2. Nine determinations, by titration (average)	9.74
No. 3. Fifteen determinations, by titration (average)	9.77
No. 1. One polarization	9.63
No. 2. One determination of total solids	9.70
The lowest result was	9.50
The highest result was	9.98

It may be assumed, therefore, that *the greatest error is not more than minus one-tenth or plus three-tenths of one per cent.*, which, in the work under hand, cannot be considered excessive.

In order to have a check on the process when applied to juices as well as pure sugar solutions, polarizations were made in a large number of cases. Where the percentage of glucose or of invert sugar was small, the agreement was close; but in the presence of these sugars the results naturally fell below those by titration, the latter being more correct. The following table gives a series of observations:

Corn juices.				Sorghum juices.							
Number of analysis.	Sucrose by polariscope.	Sucrose by titration.	Glucose.	Number of analysis.	Sucrose by polariscope.	Sucrose by titration.	Glucose.	Number of analysis.	Sucrose by polariscope.	Sucrose by titration.	Glucose.
1937	10.60	10.41	....	2006	13.56	13.61	2.16	2039	13.66	12.80	2.50
38	8.62	8.58	....	8	14.24	14.48	1.35	40	12.94	13.21	2.09
39	6.74	6.64	....	9	14.86	14.92	.84	41	13.28	12.86	2.44
41	6.81	6.72	....	*10	14.76	15.49	.59	42	12.93	13.29	2.44
42	7.03	7.09	....	14	10.84	10.56	1.44	43	12.86	12.51	1.28
43	7.48	7.62	....	15	10.20	10.00	1.41	*44	13.25	11.65	1.76
44	8.02	8.16	....	16	10.20	10.61	1.47	50	12.96	13.21	1.15
45	11.64	11.72	....	18	10.73	11.22	1.64	51	13.65	14.09	1.75
*46	4.91	5.85	....	*22	4.48	6.39	2.16	52	13.49	13.87	1.96
*47	1.86	2.71	....	24	12.88	13.00	1.67	*53	12.51	14.01	2.19
*1948	3.28	1.63	....	2027	11.96	11.76	1.95	2054	12.98	13.13	2.16
*52	11.80	8.70	....	28	14.21	13.62	1.74	55	12.43	12.60	2.39
53	9.93	9.81	....	29	13.32	12.79	2.13	56	12.08	11.55	2.39
54	9.48	9.11	....	31	13.20	13.10	1.28	57	12.80	13.03	2.07
55	8.75	8.56	....	32	11.36	11.74	1.27	58	13.49	12.95	2.23
56	6.04	5.89	....	33	13.86	13.54	.97	59	13.05	13.35	1.97
57	9.46	9.49	....	34	13.90	14.05	1.09	60	12.58	12.81	2.24
58	7.33	7.29	....	35	12.13	12.09	1.93	61	13.60	13.60	2.06
79	6.41	6.74	4.57	36	12.56	12.52	2.18	63	12.13	12.13	1.86
80	5.84	6.19	4.56	37	12.46	12.77	2.01	64	11.98	12.72	2.59
81	6.66	5.97	1.92	38	12.55	12.91	2.34	65	13.26	13.88	1.90

In this table, which contains the polarization of all the juices in a consecutive series which were clear enough for the purpose after defecation, the agreement is satisfactory in all but a few instances, marked with an asterisk, and these cases are more easily explained by errors in the polariscope work than in titration. The results which are given are only a few out of several hundred similar ones which show an equally close agreement.

The conclusions which may be drawn from our experiments are that, in experienced hands, the relative results are to be entirely relied upon, and when the conditions which have been detailed are followed the absolute results are also satisfactory.

POLARIZATION OF JUICES AND SIRUPS.

During this season, for the purpose of control, and because the results of the polariscope are generally if not better understood, at least more readily accepted as conclusive, we have made daily use of the polariscope for the purpose of determining the content of sucrose in the juices and sirups analyzed.

This method was also pursued in the work of 1879, though not to so great an extent; but as evidence of the correctness of the analytical results, the average results of the polariscope then attained are given for purpose of comparison:

	Number of analyses.	Average sucrose by analysis.	Average sucrose by polariscope.
		Per cent.	*Per cent.*
Sorghum	22	13.26	13.15
Sugar Cane	6	13.30	12.09

It will be seen that in each case the results with the polariscope are slightly less than by the analytical method, and the same result appears almost invariably true this year. It is possible that the glucose present in these juices may have a left-handed rotation as a whole, and, indeed, owing to the uniformity of this result, especially in view of the nearly constant results secured by analytical method, such an explanation seems highly probable.

In any event, however, the difference, as will be seen, is so small as to make very little practical difference, and we may therefore with confidence accept the foregoing results as being as nearly correct as could be desired, and quite near enough to the exact truth for all practical purposes, since a difference of only 4 per cent. between analysis and the polariscope would necessitate, even if the action of the glucose above referred to was shown to be nothing, only a change of a fraction of a per cent. in estimating the amount of sugar in any sample of juice.

The following table gives the results of analysis and polarization for juices of maize and sorghum containing different percentages of sugar. It will be seen that the average results of 697 analyses of sorghum juices give an average result by the polariscope 95.96 per cent. of the results by analyses, and the average results of 103 analyses of maize juices give by the polariscope 94.87 per cent. of the average results obtained by analysis.

Comparison of analyses and polarization of sorghum juices.

	1 to 2 per cent.		2 to 3 per cent.		3 to 4 per cent.		4 to 5 per cent.		5 to 6 per cent.		6 to 7 per cent.		7 to 8 per cent.		8 to 9 per cent.		9 to 10 per cent.	
	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.
	3.36	2.61	5.54	4.36	7.46	6.54	18.60	17.04	11.58	8.72	18.72	15.93	22.86	22.23	26.10	26.91	18.52	18.38
	3.64	2.56	2.73	2.81	6.04	5.80	4.55	3.95	5.67	5.10	6.52	7.01	15.62	16.18	16.50	16.10	37.04	39.36
			2.82	3.02	3.24	2.17	4.88	4.37	5.49	5.80	6.76	6.25	7.93	7.75	17.00	13.46	9.21	8.12
					3.04	2.78	4.83	4.65	16.56	21.69	6.74	6.96	7.84	7.53	8.29	7.51	19.58	17.96
					7.58	5.84	3.12	7.54	11.52	15.54	6.18	6.02	7.71	7.15	8.01	7.69	9.55	8.98
					3.88	3.11	4.52	3.85	15.84	18.80	6.70	5.04	23.46	23.52	8.84	8.15	9.98	9.54
					7.40	5.52	4.75	3.89	16.83	20.48	18.42	17.82	7.46	7.17	8.32	7.20	9.04	8.82
					6.28	5.62	4.41	3.74	10.52	10.78	26.46	18.42	14.94	18.18	8.07	7.75	18.56	15.92
					7.90	6.46	4.66	4.14	5.23	5.21	6.38	5.86	14.02	13.90	8.98	8.06	9.11	9.20
					3.19	3.69	4.19	3.72	10.94	6.58	6.22	5.11	39.10	39.40	8.30	7.98	19.34	14.30
					7.94	6.32	4.99	4.28	11.68	10.92	20.79	21.08	7.59	7.27	32.24	34.88	9.33	8.94
					3.08	2.29	4.72	3.81	11.23	10.72	6.77	6.60	14.26	10.42	33.60	32.56	9.05	8.16
							4.88	4.56	5.62	5.84	24.44	23.96	7.98	7.75	8.58	7.89	9.62	9.92
							4.24	3.79	5.96	5.92	18.84	18.18	7.75	7.44	16.10	15.86	9.18	7.77
									10.82	10.12	6.68	6.23	21.78	23.07	33.64	29.16	9.65	9.42
									5.54	5.48	6.77	6.06	23.46	22.32	16.14	13.26	27.45	26.97
									5.04	4.18	27.76	27.44	7.41	7.45	8.82	8.32	9.96	9.48
									5.89	5.24	18.75	16.23	15.80	15.32	8.77	8.62	38.84	34.76
									5.96	5.68	18.12	18.20	7.64	5.61	16.68	16.80	28.59	28.74
									16.86	15.89	19.47	19.62	7.95	6.99	17.04	14.74	19.78	17.76
									5.75	5.52	18.18	12.56	7.23	5.55			19.32	17.26
									11.28	9.82	20.22	25.53	7.74	7.08			18.20	16.18
									5.67	4.20	6.91	6.60	7.30	6.26			9.02	7.90
									5.82	3.87	6.14	5.80	7.68	6.66				
											12.58	12.86						
											6.97	5.95						
Total ..	7.00	5.17	11.09	10.19	62.08	56.14	82.29	72.88	222.79	220.55	337.84	332.25	311.86	297.21	310.02	291.40	377.92	358.74
Av.....	1.75	1.29	2.77	2.55	3.26	2.95	4.57	4.02	5.57	5.51	6.21	6.15	7.61	7.25	8.38	7.87	9.96	9.31

Comparison of analyses and polarization of sorghum juices—Continued.

10 to 11 per cent.		11 to 12 per cent.		12 to 13 per cent.		13 to 14 per cent.		14 to 15 per cent.		15 to 16 per cent.		16 to 17 per cent.		17 to 18 per cent.		18 to 19 per cent.	
Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.
10.07	9.44	22.28	20.54	12.25	11.30	55.00	55.04	14.27	13.88	15.15	14.26	16.90	16.18	35.30	32.54	36.84	33.84
20.02	21.30	11.34	10.99	12.96	12.83	41.82	41.85	29.38	27.92	62.80	62.72	16.59	15.72	35.04	33.86	37.30	37.40
20.18	23.58	11.02	10.67	33.97	33.10	27.30	28.18	14.28	17.01	30.80	31.40	33.52	29.12	35.04	31.96	18.15	18.02
41.80	38.96	33.66	37.50	24.94	25.24	13.84	13.00	14.64	14.29	31.64	30.46	32.08	32.48	35.02	33.94	18.24	17.14
31.89	31.05	23.00	20.60	50.00	47.64	27.96	29.32	57.73	61.64	31.24	24.84	32.22	31.64	53.41	43.65		
21.64	20.72	11.78	11.12	12.07	10.96	30.84	43.41	14.80	13.96	31.70	31.06	32.60	31.88	34.60	31.90		
10.28	9.89	35.13	28.77	37.05	40.08	27.22	29.50	14.64	14.03	31.00	30.46	16.84	16.36	35.20	34.20		
10.69	13.55	44.44	48.72	50.04	43.08	41.96	46.15	14.90	13.53	31.46	28.50	16.12	17.55	34.42	32.98		
10.47	9.78	23.80	20.00	12.22	12.13	58.80	58.08	14.86	14.22	62.82	57.80	33.18	31.26	17.19	16.41		
10.48	9.03	11.25	10.65	25.26	24.38	26.76	28.26	42.26	30.84	30.82	30.78	16.40	16.58	35.60	35.16		
10.67	10.03	22.32	18.96	37.23	32.85	13.17	12.84	28.16	27.20	15.14	14.82	16.54	16.28	17.26	16.74		
30.57	29.37	34.59	30.24	24.60	23.88	55.24	57.04	29.06	27.76	30.38	28.40	16.95	16.57	17.22	16.87		
10.93	10.73	23.90	23.20	12.05	11.79	52.12	51.00	28.06	24.08	15.96	15.41	16.90	16.90	17.38	16.41		
21.86	21.84	11.60	11.18	12.88	13.20	54.00	52.72	14.67	14.38	15.22	15.16	16.34	15.31	17.44	17.74		
31.38	28.41	35.32	33.97	49.48	49.76	13.64	12.98	14.74	14.58	15.79	15.13	16.85	16.34	17.64	15.13		
41.48	40.40	22.50	21.30	37.28	41.22	55.80	58.08	44.79	45.46	30.08	27.80	32.86	29.80				
32.46	31.77	11.88	11.38	25.60	13.46	26.14	28.98	28.80	28.42	30.08	28.42	16.06	15.78				
10.25	9.14	11.62	11.21	12.39	11.91	13.72	11.48	42.71	42.82	15.97	14.79	32.92	30.36				
32.81	31.68	23.94	21.60	12.08	11.22	13.88	14.04	28.68	28.13	31.76	29.38						
21.00	21.62	22.70	19.44	12.88	12.66	13.98	12.28	28.42	27.90	15.48	13.47						
10.28	10.26	47.60	45.50	37.74	34.80	26.40	27.12	42.35	42.15	15.49	14.89						
10.95	10.95	11.06	10.81	25.10	24.08	26.84	25.50	14.13	14.69	30.30	22.13						
		11.99	11.38	25.30	24.24	54.76	52.24	50.08	58.08	31.64	28.80						
		11.83	11.43	33.22	37.02	53.00	51.04	14.50	14.07	15.52	15.05						
		11.66	10.69	36.54	35.67	13.31	12.00	43.28	45.33	15.18	13.47						
		11.80	11.56	12.27	10.78	13.31	13.65	14.38	13.28	15.78	15.26						
		11.89	11.50	12.64	12.19	13.17	13.70	14.35	14.41	31.06	29.58						
		11.89	11.14	12.27	12.25	26.66	26.96	14.23	14.81	15.40	14.19						
		11.66	11.25	12.20	11.43	53.16	52.44	14.80	13.88								
		11.16	10.68	12.78	12.04	28.30	28.22	28.86	26.70								
		11.82	10.94	24.70	23.24	13.24	12.96	14.28	12.74								
		11.18	10.69	25.80	24.30	40.32	38.48	14.29	13.88								
		11.57	10.89	12.40	11.28	55.24	52.60	14.26	13.30								
		11.55	10.48	24.30	21.58	13.06	13.56	14.44	14.28								
		11.27	9.32	48.44	47.12	13.00	13.19	14.07	13.81								
		22.52	17.96	51.24	50.64	27.64	26.24	14.86	14.41								
				24.24	25.60	13.45	11.65	14.03	12.63								

......	......	......	......	12.97	12.68	13.58	12.77	14.70	14.04	......	......	......	......	......	......	......	......
......	......	......	......	12.30	11.76	13.56	12.02	......	......	......	......	......	......	......	......	......	......
......	......	......	......	12.88	11.55	13.39	12.70	......	......	......	......	......	......	......	......	......	......
......	......	......	......	12.57	12.29	13.14	12.32	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	13.88	12.90	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	13.03	12.71	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	13.55	13.11	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	13.55	13.41	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	13.07	12.59	......	......	......	......	......	......	......	......	......	......
Total .451.66	443.50	680.81	652.07	1,009.14	946.99	1,272.63	1,257.19	890.76	868.98	766.51	699.47	412.34	397.04	436.26	409.94	110.53	107.60
Av ... 10.50	10.31	11.64	11.05	12.61	11.84	13.54	13.37	14.37	14.02	15.55	14.57	16.49	15.88	17.45	16.40	18.42	17.88

Comparison of analyses and polarizations of maize juices.

	1 to 2 per cent.		2 to 3 per cent.		3 to 4 per cent.		4 to 5 per cent.		5 to 6 per cent.		6 to 7 per cent.	
	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.
	1.77	1.47	2.31	2.16	3.85	3.66	4.36	4.24	11.58	10.60	6.13	5.90
	1.47	1.27	2.47	2.26	7.96	7.46	4.81	4.61	10.06	6.36	6.95	7.15
					3.31	2.08	9.90	8.88	10.68	9.82	12.40	11.80
					3.12	2.83	9.50	8.40	11.76	10.22	6.90	7.03
					3.53	3.24	4.01	5.10	5.20	7.01	6.16	5.25
					3.56	2.80	4.29	3.95	10.44	12.82	6.87	6.40
							4.29	3.75	11.14	10.72		
							9.30	9.26	10.62	10.52		
							4.30	4.36	16.17	17.13		
							4.40	3.65	5.82	5.54		
									5.12	4.89		
									5.94	5.20		
Total	3.24	2.74	4.78	4.42	25.33	22.07	59.16	56.20	114.53	110.83	45.41	43.53
Average	1.62	1.37	3.39	2.21	3.62	3.36	4.55	4.32	5.45	5.25	6.49	6.22

	7 to 8 per cent.		8 to 9 per cent.		9 to 10 per cent.		10 to 11 per cent.		11 to 12 per cent.		12 to 13 per cent.		13 to 14 per cent.	
	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.	Analysis.	Polarization.
	7.85	7.44	8.40	6.06	9.27	7.92	10.67	10.49	11.02	10.98	12.55	11.74	26.40	21.68
	14.12	10.52	8.32	8.03	9.97	8.14	30.60	34.71	11.39	11.44				
	7.19	7.04	16.64	24.74	9.97	8.73	20.88	20.50	23.14	20.98				
	15.60	19.06	8.24	7.58	9.51	9.39	54.95	49.85	23.30	21.70				
	7.16	6.97	8.13	8.34			42.08	43.92						
	7.58	7.02												
	14.72	13.30												
	15.28	12.26												
	7.59	7.28												
	15.06	15.08												
	15.36	14.62												
Total	127.51	120.59	49.73	54.75	38.72	34.18	159.27	159.47	68.85	65.10	12.55	11.74	26.40	21.68
Average	7.50	7.09	8.29	9.12	9.68	8.54	10.62	10.63	11.47	10.85	12.55	11.74	13.20	10.84

Summary of analyses and polarizations of sorghum and maize juices.

SORGHUM.

Number of determinations.	Sucrose by analysis.	Sucrose by polarization.
4	7.00	5.17
4	11.09	10.19
19	62.03	56.14
18	82.29	72.83
40	222.79	220.55
52	337.34	332.25
41	311.86	297.21
37	310.02	291.40
40	377.92	353.74
43	451.66	443.50
59	690.81	652.07
80	1009.14	946.99
94	1272.63	1257.19
62	890.76	868.98
48	746.51	699.47
25	412.34	397.04
25	436.26	409.94
6	110.83	107.00
697	7,732.98	7,421.16
Ratio	100	95.96

Summary of analyses and polarizations of sorghum and maize juices—Continued.

CORN.

Number of determinations.	Sucrose by analysis.	Sucrose by polarization
2	3.24	2.74
2	4.78	4.42
7	25.83	22.07
13	59.16	56.20
21	114.58	110.83
7	45.41	43.53
17	127.51	120.59
6	49.78	54.75
4	38.72	34.18
15	159.27	159.47
6	68.85	65.10
1	12.55	11.74
2	26.40	21.68
103	745.48	707.30
Ratio	100 :	94.87

PERIOD FOR WORKING THE SORGHUMS.

In the following table is given the working period for the different varieties of sorghum, the number of analyses made during this period, and the maximum, minimum, and average per cent. of available sugar during this period.

The average number of analyses of each variety is 15, so that these results may be relied upon with confidence. The entire period is from July 30 to November 17, thus allowing 110 days in this latitude for working up the crops, which may be so planted or selected among the different varieties as to enable each crop to reach its maximum value at the time of being worked up.

The average minimum of available sugar of the thirty-five varieties is 6.44 per cent., while the average maximum is 12.51 per cent. The average of the best half of the thirty-five varieties during the entire period is 10.97 per cent., while the average of the poorer half during the entire working period is 8.63 per cent. The average of the entire number during their entire working period is 9.77 per cent. of available sugar.

It will be remembered that these varieties were planted April 29, so that the length of time for each to reach the condition represented by these averages may be readily determined, and are given in one of the columns.

As will be seen, this period varies from 92 to 139 days, and several of these later maturing varieties appear even in this latitude to have failed in reaching their best condition, as will be seen in the fact that their maximum of available sugar falls far below that of other varieties of shorter periods of development. In fact, many of these varieties cannot be successfully grown for sugar, perhaps, except in the Gulf States.

Owing to the fact that the amount of sirup which may be produced from a juice depends upon the sum of the sucrose and glucose, it is obvious that sirup may be produced from the canes in any condition of maturity; but even for sirup production, it will be seen by reference to the tables of analyses of the several varieties that the maximum of sirup may be produced at the same period when the sorghum may be most profitably worked for sugar, since at that time the sum of the two sugars is also at its maximum. For the production, then, of either sugar or sirup it is desirable that only such varieties should be grown in any locality as may be able to reach full maturity.

Period for working the different varieties of sorghum.

Variety.	Number of determinations.	Number of days.	From—	To—	Minimum available sugar.	Maximum available sugar.	Average available sugar.	April 29 to the working period.
					Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Days.*
Early Amber	24	106	Aug. 3	Nov. 17	6.06	14.62	10.12	96
Early Golden	26	110	July 30	Nov. 17	7.06	14.00	10.02	92
White Liberian	25	110	July 30	Nov. 17	6.71	14.77	10.41	92
Do	25	110	July 30	Nov. 17	6.71	15.12	10.61	92
Black Top	15	76	Aug. 15	Oct. 30	7.70	15.15	11.08	108
African	20	85	Aug. 24	Nov. 17	5.16	14.00	9.82	117
White Mammoth	9	42	Aug. 29	Oct. 10	8.46	12.51	10.60	122
Oomseeana	15	75	Aug. 16	Oct. 30	4.87	13.46	10.76	109
Regular Sorgho	7	18	Aug. 25	Sept. 12	8.90	11.76	9.78	118
Link's Hybrid	21	106	Aug. 3	Nov. 17	7.39	14.58	11.02	96
Do	23	97	Aug. 12	Nov. 17	7.98	14.87	11.36	105
Sugar Cane	23	103	Aug. 6	Nov. 17	8.17	12.81	10.86	99
Goose Neck	6	16	Aug. 29	Sept. 14	10.09	11.90	11.34	122
Bear Tail	10	56	Aug. 16	Oct. 10	7.43	11.59	9.76	109
Iowa Red Top	18	70	Aug. 11	Oct. 20	9.26	14.17	12.64	104
New Variety	19	92	July 30	Oct. 30	5.63	14.98	11.63	92
Early Orange	14	72	Aug. 19	Oct. 30	5.28	15.05	10.73	112
Do	19	86	Aug. 23	Nov. 17	6.83	12.25	9.91	116
Orange Cane	14	71	Aug. 20	Oct. 30	4.95	11.44	9.56	113
Neeazana	20	89	Aug. 20	Nov. 17	2.58	9.07	6.78	113
Wolf Tail	24	94	Aug. 15	Nov. 17	7.15	12.21	9.67	108
Gray Top	21	90	Aug. 19	Nov. 17	3.33	9.00	6.79	112
Liberian	7	38	Sept. 2	Oct. 10	4.64	11.89	8.55	126
Mastodon	9	41	Aug. 30	Oct. 10	3.54	11.57	8.05	123
Honduras	7	25	Sept. 2	Sept. 27	1.80	8.39	6.56	126
Sugar Cane	11	62	Aug. 19	Oct. 20	2.94	10.31	7.82	112
Hybrid No. 4	4	8	Aug. 26	Sept. 3	8.85	10.20	9.45	119
White Imphee	8	56	Aug. 15	Oct. 10	8.06	15.86	11.90	108
Goose Neck	13	72	Aug. 19	Oct. 30	6.78	12.17	9.29	112
White African	20	97	Aug. 10	Nov. 15	4.58	12.04	8.11	103
West India Sugar Cane	6	49	Aug. 14	Oct. 2	7.67	14.10	10.70	107
Sugar Cane	4	23	Sept. 7	Sept. 30	6.51	11.27	8.76	131
New Variety, of Liberian and Oomseeana	10	51	Aug. 8	Sept. 28	6.81	9.84	8.30	101
Minnesota Early Amber	10	53	Aug. 8	Sept. 30	8.28	12.17	10.78	101
Honey Cane	2	15	Sept. 15	Sept. 30	7.22	8.15	7.65	139

EXPERIMENTS WITH THE SMALL MILL.

Near the close of the season, when some varieties, as will be seen from the tables of analyses, had already begun to fall off in their content of sugar, and other varieties were still improving in quality, the crop of sorghum was cut up, leaving enough of each variety standing in order to continue and complete the daily analyses going on in the laboratory.

The several lots were in succession cut up, weighed, and the juice obtained from each lot, and a sample analyzed.

The juice was defecated with milk of lime, as usual, and the defecated juice evaporated in an open pan to a sirup sufficiently dense to be kept without danger of fermentation. The sirup was weighed and also analyzed.

The apparatus used in these experiments was the same used in our former experiments, with the exception of the mill, which was a new one.

The object of these experiments was to determine whether it was not possible to prepare, with simple and inexpensive apparatus, such as the ordinary farmer might possess, sirups of high grade, *i. e.*, containing a large percentage of sugar, which sirups it was intended to further reduce and crystallize in the vacuum pan of the large mill, and thus show the farmer that he could, with little expense, prepare sirups from which sugar could be profitably extracted; and also to convince refiners and others by our results that they could safely purchase these sirups and as readily obtain from them the sugar as from similar products from the sugar cane.

Our results in 1878 and 1879 had sufficiently demonstrated the ease with which crystallizable sugar could be obtained even with this simple outfit, but the practical difficulty experienced in purging it without a centrifugal machine was such as to warrant us in recommending the farmer not to endeavor to make sugar, but to make these high-grade sirups, as then he would able to secure a local market for consumption as sirups, or, should the product be very great, the refiners would become purchasers so soon as they were convinced that they could safely and profitably work these sirups for sugar.

As evidence that our work in previous years sufficed to warrant our discontinuing experiments in that direction, those results are here given, from which it will be seen that we then obtained an amount of sugar fairly comparable with the average results from sugar cane. In 1878 we obtained sirups from the juices of sorghum, maize and pearl millet of very excellent quality in their content of sugar, and we obtained from these sirups sugars of a high grade when compared with other muscovado sugars as these were. The sorghum sugar polarized 94°, the maize sugar polarized 90°, and the sugar from pearl millet 92°.

Besides, the yield of the sirup in sugar was larger, the sorghum sirup giving in its first crystallization 34.6 per cent. of its weight in sugar, another sample 31.3 per cent.; the maize sirup giving in sugar 32 per cent. of its weight.

In 1879 we obtained sirups from sorghum, which in their first crystallization yielded 54.7 per cent. of its weight in sugar of excellent quality; another sirup gave 47.5 per cent., while a sirup from the stalks of common field corn gave 39.3 per cent. of sugar.

The above results fully justified the conclusion given in the report of the work of 1878, viz:

> The point which these experiments have fully settled is, that there exists no difficulty in making from either corn or sorghum a first rate quality of sugar, which will compare favorably with the best product from sugar cane grown in the most favorable localities.

During the past three years nothing has been done or been developed by later investigations to necessitate any modification of the above conclusion. Since then our efforts have been directed towards the determination of those conditions which would render such production the most profitable, and the continued and careful study of these several plants during their period of life has appeared most likely to throw light upon practical work.

Besides the experimental plat of sorghum upon the department grounds, there were grown, as has been already stated, numerous small plats of these several varieties upon the farm of Mr. Golden, near Uniontown; also small plats of several kinds of maize upon the farm of Dr. Dean, near Benning's Station; also a small plat of six varieties of sorghum by Mr. Green upon the Potomac flats at the Virginia end of the Long Bridge. These small plats were intended to be worked up upon the small mill, and for the purpose of learning their relative productiveness and value in the production of good sirups rich in sugar.

The number of separate experiments made with the small mill was 40, and these extended from September 12 to October 22.

The following tables give every detail concerning these experiments, and will repay a very careful consideration. Analyses of juices and sirups, weights of stalks and average yield, percentages of juice and of sirups, time occupied in each operation, temperatures of defecation, and in fact any detail calculated to throw light upon these results is given.

And in reference to these results, which have proved in many respects so surprising, many may see abundant reason for any failure which has attended their efforts, and will be impressed with the importance of establishing by careful experiment points which by many would be readily assumed as true, and even with a show of reason, but which in fact may be far different from their preconceived ideas.

EXPERIMENTS WITH SMALL MILL.

No. of experiment.	Variety.	Date of working.	Where grown.	Stripped weight, pounds.	Feet in row.	Suckered or not.	Juice, pounds.	Per cent. of juice to stripped stalk.	Specific gravity of juice.	Polarization of juice.	Per cent. of sucrose in juice.	Per cent. of glucose in juice.	Per cent. of solids in juice.	Stripped stalk per acre, pounds.	Per cent. sucrose in juice available.
1	Egyptian Sugar Corn, ears plucked	Sept. 12	Department of Agriculture.	16	......	Yes...	6	37.5	1.058	Lost..	9.54	2.89	2.50	....	4.15
	Egyptian Sugar Corn, ears unplucked....	Sept. 12	....do	65	......	Yes...	20.5	31.5	1.056	Lost..	10.41	2.78	1.15	6,729	6.48
	Lindsay's Horse Tooth	Sept. 12	....do	67	240	Yes...	30	44.8	1.053	8.42	8.98	2.40	3.00	5,772	3.58
	Blount's Prolific..........	Sept. 12	....do	17	240	Yes...	6	35.3	....	Lost..	....	....	....	2,203	....
	Improved Prolific Bread..........	Sept. 12	....do	204	240	Yes...	81.5	40.0	1.018	Lost..	7.86	1.99	2.60	12,750	3.27
	Broad White Flat Dent	Sept. 12	....do	290	240	Yes...	115.5	39.8	1.051	Lost..	7.79	2.49	2.46	16,744	2.84
	Long Narrow White Dent..........	Sept. 12	....do	279	240	Yes...	123.5	41.3	1.055	8.60	9.48	2.01	1.59	16,146	5.88
	Chester County Mammoth	Sept. 12	....do	94	240	Yes...	35.5	37.8	1.061	Lost..	10.90	1.64	2.96	6,557	6.30
	18-rowed Yellow Dent	Sept. 12	....do	158	240	Yes...	61.5	38.9	1.056	8.76	8.28	2.42	2.79	9,838	3.07
2	Early Amber ....Row 1	Sept. 13	....do	341	200	Not...	148	43.4	1.088	Lost..	15.56	2.52	.99	24,757	12.05
	Early Golden ....Row 2	Sept. 13	....do	477.5	200	Not...	221	46.3	1.085	16.39	10.52	2.07	1.69	34,607	12.76
	White Liberian ....Row 3	Sept. 13	....do	304	200	Not...	177	48.6	1.080	15.68	14.62	1.62	4.45	26,426	9.61
	White Liberian ....Row 4	Sept. 13	....do	406.5	200	Not...	206	50.7	1.079	15.10	13.60	1.67	4.55	29,512	7.38
3	Black Top ....Row 5	Sept. 14	....do	648	280	Not...	217	......	1.070	9.76	9.76	3.50	6.17	33,603	.09
	African ....Row 6	Sept. 14	....do	378	260	Not...	198.5	52.5	1.067	10.29	10.41	2.87	5.32	21,110	2.22
	Regular Sorgho ....Row 9	Sept. 14	....do	416	285	Not...	212	51	1.056	7.09	7.33	3.59	4.79	21,194	−1.03
4	Miller's Sugar Cane..........No. 26	Sept. 15	Golden	1,292	......	Yes...	594.5	46.0	1.052	5.58	7.47	4.96	3.16	....	−.65
5	Wallis Hybrid ....No. 27	Sept. 15	....do	761	......	Yes...	380.5	49.8	1.062	6.67	8.45	5.82	3.62	....	−.99
6	Bear Tail ....No. 14	Sept. 15	....do	1,628	......	Yes...	770.5	47.3	1.051	4.49	6.50	5.88	3.60	....	−2.98
7	Bear Tail ....No. 14	Sept. 16	....do	264	......	Yes...	130	49.2	1.051	Lost..	6.50	5.88	3.60	....	−2.98
	Iowa Red Top ....No. 15	Sept. 16	....do	1,170	......	Yes...	582.5	49.8	1.058	4.81	6.91	6.91	2.24	....	−2.24
8	Oomseeana..........Row 8	Sept. 16	Department of Agriculture.	342	267	Not...	174.	50.9	1.069	8.54	10.06	4.73	3.49	18,599	1.84
	White Mammoth..........Row 7	Sept. 16	....do	509	270	Not...	251	49.3	1.074	10.86	11.76	3.79	4.46	27,373	3.51
9	Link's Hybrid ....Row 10	Sept. 17	....do	558	280	Not...	285.5	51.1	1.067	11.39	12.08	1.86	2.64	28,936	7.58
	Link's Hybrid ....Row 11	Sept. 17	....do	583	285	Not...	307	52.7	1.062	12.20	13.06	1.33	2.63	29,702	9.10
10	Sugar Cane..........Row 12	Sept. 17	....do	592	285	Not...	314	53	1.066	11.28	11.94	1.46	2.78	30,161	7.70
	Goose Neck..........Row 13	Sept. 17	....do	433.5	285	Not...	243.5	56.2	1.050	5.45	6.35	4.07	2.29	22,086	−.01
11	Bear Tail ....Row 14	Sept. 19	....do	486	285	Not...	237	48.8	1.065	10.08	10.92	2.41	5.35	21,232	3.16
	Iowa Red Top ....Row 15	Sept. 19	....do	429	285	Not...	214	49.9	1.075	Lost..	14.63	1.43	7.21	21,856	5.97
12	Egyptian Sugar Corn..........	Sept. 20	Dr. Dean	1,600	......	Yes...	646	40.4	1.056	8.40	8.29	3.65	5.65	....	−1.01
13	New Variety ....Row 16	Sept. 27	Department of Agriculture.	575	285	Not...	262.5	45.7	1.068	Lost..	12.67	1.90	2.75	29,294	8.02
	Early Orange ....Row 17	Sept. 27	....do	381	178	Not...	168	44.1	1.065	10.04	10.57	3.09	2.12	31,079	4.76
	Early Orange ....Row 18	Sept. 27	....do	253	154	Not..	100.5	39.8	1.064	9.80	13.57	3.38	−.45	23,584	10.19
	Orange Cane..........Row 19	Sept. 27	....do	327	154	Not...	139.5	42.7	1.067	10.50	10.95	3.35	2.42	30,831	5.18

EXPERIMENTS WITH SMALL MILL—Continued.

No. of experiment.	Variety.	Date of working.	Where grown.	Stripped weight, pounds.	Feet in row.	Suckered or not.	Juice, pounds.	Per cent. of juice to stripped stalk.	Specific gravity of juice.	Polarization of juice.	Per cent. of sucrose in juice.	Per cent. of glucose in juice.	Per cent. of solids in juice.	Stripped stalk per acre, pounds.	Per cent. sucrose in juice available.
	Neeazana .... Row 20	Sept. 27	Department of Agriculture.	314.5	174	Not...	130	41.3	1.063	9.39	9.94	3.80	2.72	26,244	3.42
14	Early Amber........ No. 1	Sept. 27	Golden	985	......	Yes...	423.5	44.2	1.063	.07	8.75	10.85	2.80	....	— 9.90
	Early Golden........ No. 2	Sept. 27	....do	640	......	Yes...	289	45.1	1.069	.00	8.66	11.69	3.07	....	—10.10
15	White Liberian........ No. 3	Sept. 28	....do	1,220	......	Yes...	495.5	40.6	1.070	.00	2.30	13.25	2.48	....	—13.43
	New Variety........ No. 16	Sept. 28	....do	775	......	Yes...	354	45.7	1.057	4.98	5.74	7.56	2.02	....	— 3.84
16	White Liberian........ No. 4	Sept. 28	....do	3,840	......	Yes...	1,137.5	45.2	....	6.64	....	....	....	....	....
17	Wolf Tail........ Row 21	Sept. 29	Department of Agriculture.	390	168	Not...	172.5	44.2	1.068	11.56	11.67	1.87	3.54	33,707	6.26
	Gray Top........ Row 22	Sept. 29	....do	490	230	Not...	218.5	44.6	1.052	7.31	.56!	3.08	9.90	30,931	—12.42
	Liberian........ Row 23	Sept. 29	....do	560	280	Not...	250	44.6	1.059	8.34	8.18	4.24	3.16	29,040	.78
18	Honduras........ No. 42	Sept. 30	Golden	1,105	......	Yes...	366	33.1	1.048	Lost..	1.92	10.07	2.15	....	—10.30
	Neeazana........ No. 50	Sept. 30	....do	1,085	......	Yes...	518.5	47.8	1.058	Lost..	8.84	4.72	2.27	....	1.85
	Liberian........ No. 51	Sept. 30	....do	930	......	Yes...	421	45.3	1.066	5.79	6.34	9.14	3.28	....	— 6.08
19	Mastodon........ Row 24	Sept. 30	Department of Agriculture.	598	290	Not...	307	51.3	1.051	8.15	8.24	3.09	4.22	29,941	.93
	Honduras........ Row 25	Sept. 30	....do	688	290	Not...	375	54.5	1.062	9.24	8.47	5.06	3.74	34,447	— .33
20	Oomseeana........ No. 8	Oct. 1	Golden	2,222	......	Yes...	1,045.5	47.1	1.055	2.76	6.30	6.57	2.24	....	— 2.51
21	Liberian........ No. 51	Oct. 3	....do	750	......	Yes...	316.5	42.2	1.072	1.04	5.16	10.78	2.53	....	—12.15
	Oomseeana........ No. 8	Oct. 3	....do	494	......	Yes...	211	42.7	1.050	1.05	2.62	10.45	2.41	....	—10.24
	Regular Sorgho........ No. 9	Oct. 3	....do	1,260	......	Yes...	606	48.1	1.060	2.44	3.80	9.67	2.70	....	— 8.57
22	Oomseeana........ No. 8	Oct. 3	....do	2,620	......	Yes...	1,085	41.4	1.057	2.68	3.32	8.92	3.46	....	— 9.06
23	Goose Neck........ No. 13	Oct. 4	....do	2,416	......	Yes...	1,162.5	48.1	1.065	7.36	7.26	7.10	1.19	....	— 1.08
24	Regular Sorgho........ No. 9	Oct. 4	....do	2,300	......	Yes...	1,055	45.9	1.067	.70	2.67	11.94	1.51	....	—10.78
25	Goose Neck........ No. 13	Oct. 5	....do	474	......	Yes...	222.5	46.9	1.067	5.38	7.12	8.31	1.11	....	— 2.30
	Black Top........ No. 5	Oct. 5	....do	2,042	......	Yes...	729	35.7	1.063	6.25	6.90	6.87	1.61	....	— 1.49
26	African........ No. 6	Oct. 5	....do	1,524	......	Yes...	746	49	1.059	6.09	6.95	6.01	1.59	....	— .65
27	Sugar Cane........ Row 26	Oct. 6	Department of Agriculture.	393	290	Not...	202	51.4	1.053	Lost..	6.15	3.49	3.27	19,677	— .61
	Wallis Hybrid........ Row 27	Oct. 6	....do	520	290	Not...	291.5	56.1	1.053	Lost..	5.68	4.27	2.96	26,036	— 1.55
	White Imphee........ Row 28	Oct. 6	....do	370	290	Not...	202	54.6	1.041	4.94	5.45	1.62	3.01	18,525	.82
	Goose Neck........ Row 29	Oct. 6	....do	362	290	Not...	202	55.8	1.044	3.62	3.98	3.35	3.30	18,125	— 2.67
	White African........ Row 30	Oct. 6	....do	480.5	290	Not...	249.5	51.9	1.070	Lost..	11.38	1.34	3.82	24,058	6.22
28	West India........ Row 31	Oct. 7	....do	471	290	Not...	247	52.4	1.072	9.89	11.03	4.37	1.85	23,582	4.81
	Sugar Cane........ Row 32	Oct. 7	....do	254	290	Not...	127	50	1.055	7.10	7.58	3.63	2.06	12,717	1.89
	New Variety, Barger........ Row 33	Oct. 7	....do	341.5	290	Not..	170.5	49.9	1.070	11.03	11.26	3.75	1.99	17,099	5.52
	Minnesota Early Amber........ Row 34	Oct. 7	....do	397	290	Not...	207	52.1	1.077	13.39	13.96	1.91	2.56	19,877	9.49

	Holcus Saccharatus	Row 35	Oct. 7	...do	271	290	Not...	107.5	39.7	1.049	Lost..	5.27	2.32	3.89	14,220	— .94
	Honey Cane	Row 38	Oct. 7	...do	759	290	Not...	449	59.2	1.067	10.70	11.88	3.42	1.75	39,239	6.71
29	Minnesota Early Amber	Row 34	Oct. 7	...do	105	117	Yes...	48.5	46.2	1.078	14.24	14.83	1.56	3.33	16,977	9.93
	New Variety	Row 33	Oct. 7	...do	91	119	Yes...	34.5	37.9	1.082	14.17	14.70	1.84	3.33	13,800	9.53
	Sugar Cane	Row 32	Oct. 7	...do	114	120	Yes...	60.5	53.1	1.070	12.17	12.27	2.86	2.86	16,128	6.55
	West India	Row 31	Oct. 7	...do	177	121	Yes...	83.5	47.2	1.069	14.94	15.57	1.95	3.66	24,418	9.96
	Holcus Cernus, White	Row 37	Oct. 7	...do	237.5	290	Not...	66	27.8	1.078	Lost..	13.96	1.35	2.91?	13,313	9.70
	Early Amber	Row 1	Oct. 7	...do	173	140	Yes...	78.5	45.4	1.087	Lost..	16.06	1.38	3.81	21,074	10.87
	Early Golden	Row 2	Oct. 7	...do	188.5	140	Yes...	91	48.3	1.088	15.45	15.93	1.37	3.93	23,201	10.63
	White Liberian	Row 3	Oct. 7	...do	126.5	138	Yes...	54.5	43.1	1.083	14.68	16.03	1.37	3.46	17,006	11.20
	White Liberian	Row 4	Oct. 7	...do	118	140	Yes...	56	47.5	1.098	Lost..	15.81	1.27	4.27	15,329	10.27
	Black Top	Row 5	Oct. 7	...do	196	140	Yes...	99	50.5	1.074	12.35	13.10	1.22	3.78	22,848	8.10
	African	Row 6	Oct. 7	...do	122	139	Yes...	56.5	46.3	1.074	12.12	12.89	1.97	3.11	16,327	7.81
30	White Mammoth	Row 7	Oct. 8	...do	282	139	Yes...	143.5	50.9	1.078	Lost..	13.96	1.35	2.91	33,333	9.70
	Oomseeana	Row 8	Oct. 8	...do	142.5	139	Yes...	68.5	48.1	1.075	Lost..	12.83	1.72	2.93	17,852	8.18
	Regular Sorgho	Row 9	Oct. 8	...do	175.5	139	Yes...	90.5	51.6	1.071	10.21	11.08	2.91	2.72	21,383	5.45
	Link's Hybrid	Row 10	Oct. 8	...do	281	139	Yes...	140	49.8	1.086	Lost..	16.29	.80	— .11	33,041	15.49
	Link's Hybrid	Row 11	Oct. 8	...do	250	136	Yes...	102.5	41.0	1.087	Lost..	16.78	.66	3.02	29,768	13.10
	Sugar Cane	Row 12	Oct. 8	...do	280	138	Yes...	136.5	48.8	1.088	Lost..	16.76	.74	3.18	32,103	12.84
	Goose Neck	Row 13	Oct. 8	...do	138	131	Yes...	71	51.5	1.070	Lost..	12.62	2.39	2.97	18,045	7.26
	Bear Tail	Row 14	Oct. 8	...do	151.5	131	Yes...	71	46.9	1.074	Lost..	12.58	3.16	2.32	20,461	7.10
	Iowa Red Top	Row 15	Oct. 8	...do	154.5	129	Yes...	82	53.1	1.074	Lost..	13.82	1.74	2.17	20,643	9.91
31	New Variety	Row 16	Oct. 10	...do	191.5	132	Yes...	86.5	45.2	1.079	Lost..	14.21	1.71	2.98	24,486	9.52
	Early Orange	Row 17	Oct. 10	...do	255.5	133	Yes...	136.5	53.4	1.078	13.62	13.92	1.92	2.38	30,634	9.62
	Early Orange	Row 18	Oct. 10	...do	164	134	Yes...	79	48.2	1.081	14.42	14.12	2.48	2.41	20,447	9.23
	Orange Cane	Row 19	Oct. 10	...do	206	126	Yes...	103	50.0	1.078	13.47	13.81	2.27	2.28	26,252	9.26
	Neeazana	Row 20	Oct. 10	...do	173.5	129	Yes...	82	47.3	1.075	12.01	12.10	2.84	2.31	21,915	6.95
	Wolf Tail	Row 21	Oct. 10	...do	248	129	Yes...	124	50.0	1.077	13.72	14.11	1.33	2.75	30,683	10.03
	Gray Top	Row 22	Oct. 10	...do	219	130	Yes...	110	50.2	1.071	10.68	11.48	2.62	2.30	27,979	6.56
	Liberian	Row 23	Oct. 10	...do	222	130	Yes...	111.5	50.2	1.071	9.21	9.27	5.07	2.23	27,700	1.97
32	Mastodon	Row 24	Oct. 11	...do	251.5	123	Yes...	133	52.9	1.062	9.55	10.33	2.31	2.14	33,538	5.88
	Honduras	Row 25	Oct. 11	...do	165.5	121	Yes...	93.5	56.5	1.057	6.51	7.25	5.02	1.73	24,480	.50
	Sugar Corn	Row 26	Oct. 11	...do	115.5	118	Yes...	57.5	49.8	1.063	8.68	9.72	3.52	1.90	17,215	4.30
	Wallis Hybrid	Row 27	Oct. 11	...do	104.5	115	Yes...	57.5	55.0	1.036	Lost..	7.19	5.09	1.87	17,184	.23
	White Imphee	Row 28	Oct. 11	...do	125.5	112	Yes...	63	50.2	1.068	11.09	13.52	1.55	2.06	19,382	9.91
	Goose Neck	Row 29	Oct. 11	...do	53	109	Yes...	26	49.1	1.063	10.09	11.21	2.43	2.44	10,750	6.34
	White African	Row 30	Oct. 11	...do	120	107	Yes...	58.5	48.8	1.066	Lost..	11.92	1.52	2.83	19,446	7.57
33	Corn Stalks		Oct. 12	Dr. Dean	1,397	......	......	502.5	36.0	1.029	1.91	3.57	2.91	.71	......	— .05
34	Early Amber		Oct. 13	H. Green	880	......	......	484	55.0	1.055	8.36	8.55	3.55	2.11	......	2.89
35	Do		Oct. 18	...do	1,560	......	......	780	50.0	1.059	7.57	8.16	4.75	1.82	......	1.59
36	White Liberian		Oct. 19	...do	2,590	......	......	1,246	48.1	1.069	9.34	9.50	5.44	1.57	......	2.49
37	Neeazana		Oct. 20	...do	2,420	......	......	1,196	49.4	1.068	9.80	10.18	4.97	1.14	......	4.07
38	Link's Hybrid		Oct. 21	...do	1,740	......	......	829	47.6	1.054	7.12	7.54	3.67	2.78	......	1.09
39	Liberian		Oct. 22	...do	980	......	......	496	50.6	1.054	3.70	6.06	7.02	1.10	......	—2.06
40	Honduras		Oct. 22	...do	1,270	......	......	711	56.0	1.035	1.90	2.87	5.43	1.84	......	—4.40

EXPERIMENTS WITH SMALL MILL.

Number of experiment.	Temperature of defecation.	Hours in defecator.	Hours in evaporator.	Hours in defecator.	Pounds of water added.	Per cent. of sirup to juice.	Juice lost.	Sirup made.	Polarization of sirup.	Per cent. sucrose in sirup.	Per cent. glucose in sirup.	Per cent. solids in sirup.	Per cent. sucrose in sirup available.	Per cent. sucrose of juice in sirup.	Per cent. glucose of juice in sirup.
	° F.														
1	....	....	....	....	....	13.58	55	56	46.80	47.62	11.76	19.12	16.74	70.7	70.9
2	70	1.3	2.3	....	....	27.65	None	208	48.12	40.08	4.50	13.42	28.16	93.2	57.0
3	68	1.3	2.2	17	105	19.89	59.5	113	30.91	45.32	16.15	12.98	16.19	98.7	96.5
4	60	1.5	1.1	....	....	18.55	53	100.5	35.51	40.76	30.95	15.49	— 5.68	101.0	112.1
5	70	.9	1.5	....	....	17.05	58	55	38.07	40.38	32.55	7.87	— .04	....	....
6	65	1.5	2.0	14.5	....	16.43	52.5	118	32.40	38.95	28.00	13.45	— 2.50	98.5	78.3
7	65	1.2	2.3	....	....	18.30	51.5	121	29.48	31.83	32.50	10.67	—11.34	85.2	88.5
8	65	1.1	1.7	.7	63	20.77	49.5	78.5	43.74	50.35	18.00	8.45	23.90	95.2	90.2
9	65	1.1	2.3	1.0	210	25.50	75	132	43.42	47.98	7.20	19.22	21.56	97.2	116.2
10	65	.8	2.0	1.3	168	19.42	105	88	41.88	43.23	10.00	26.97	0.26	88.5	74.8
11	70	.9	2.0	....	....	19.57	47.5	79	....	55.86	8.25	12.49	35.12	86.3	82.8
12	50	.9	2.2	....	....	14.63	44.5	88	40.80	47.98	22.75	14.27	10.96	84.4	91.0
13	60	1.1	2.5	.9	163	20.64	132	138	42.85	44.15	10.25	15.60	18.30	78.6	70.1
14	50	1.1	2.2	14.5	....	17.07	62.5	111	5.43?	17.50?	50.50	12.50?	—45.50	80.6	77.7
15	53	.9	2.7	....	....	20.30	74	157.5	16.20	18.24	39.35	14.61	—35.72	99.3	73.6
16	41	1.2	2.3	16.0	....	18.98	159.5	299.5	8.67	9.50	59.00	19.10	—68.60	....	....
17	54	1.2	....	....	168	16.79	60	97.5	45.85	46.08	20.50	19.22	6.36	80.5	105.2
18	45	1.2	4.8	1.0	126	18.95	105.5	227.5	30.94	38.29	28.20	13.91	— 3.82	119.4	69.9
19	56	1.3	2.5	15.3	126	16.64	54	104.5	36.05	38.00	18.00	13.40	4.60	75.5	71.8
20	50	1.3	3.5	.5	105	18.39	53.5	202.5	19.20	19.76	38.20	14.24	—32.68	64.0	118.6
21	50	1.5	3.5	.8	105	17.81	56	192	12.96	17.39	45.75	12.20	—40.62	78.2	80.5
22	68	1.3	3.6	15.5	....	16.81	80.5	169	14.58	22.14	41.75	4.51	—24.12	44.4	81.1
23	58	1.5	4.0	15.5	....	19.07	108.5	201	24.71	30.50	37.00	5.70	—12.20	80.1	99.4
24	50	1.2	3.5	1.0	105	22.26	58	222	5.43	14.73	49.50	16.17	—50.94	122.8	92.4
25	40	1.5	2.8	....	....	25.99	57	232.5	27.54	24.51	30.75	12.74	—18.98	90.8	110.8
26	40	1.3	2.5	16.0	....	14.52	50.5	101	35.23	36.39	34.40	12.21	—10.22	76.0	83.1
27	35	1.0	2.3	....	....	12.78	122.5	128.5	42.30	54.63	15.55	14.02	25.06	102.9	68.2
28	58	1.9	5.5	.7	147	16.46	129.5	194	51.19	53.87	14.35	19.18	20.34	80.5	71.1
29	60	1.3	3.3	14.2	....	17.14	122	104	55.40	59.85	6.50	17.45	35.90	69.9	69.7
30	54	1.7	2.7	1.0	120	22.00	164.5	167.5	59.50	50.09	7.00	16.91	35.18	93.3	102.8
31	40	1.3	2.9	.8	147	19.70	89	146.5	54.50	58.00	9.00	12.50	37.40	90.15	70.60
32	50	1.3	1.5	.9	63	18.60	59	80	45.28	45.60	12.50	12.90	20.20	85.3	74.8
33	42	1	1.7	....	....	10.23	53	46	20.25	25.46	20.75	14.39	— 9.68	70.8	72.0
34	48	1	1.5	....	....	15.19	76	62	48.60	48.26	18.25	12.49	17.52	85.8	78.1
35	44	1.3	2.5	.5	84	15.53	123.5	102	46.98	48.36	22.65	10.79	14.92	92.1	74.1
36	....	....	....	....	....	....	123	186	44.14	47.03	20.50	7.87	18.66	82.0	62.4
37	....	....	....	....	....	....	159	186.5	50.46	49.69	22.25	16.06	11.38	87.8	80.5
38	....	....	....	....	....	....	106	149	44.68	45.89	21.75	17.70	6.88	125.5	122.1
39	....	....	....	....	....	....	82	54.5	28.43	31.35	40.10	1.95	—10.70	68.3	75.3
40	....	....	....	....	....	....	48.5	72	18.81	26.79	44.35	12.86	—30.42	101.5	88.7
													Average..	87.5	82.7

ANALYSIS AND POLARIZATION OF SIRUPS.

It will be seen that, as was the case with the juices, so the sirups show a content of sugar by the polariscope almost invariably less than the amount determined by analysis; and as evidence that this perhaps is due to the presence of more or less inverted sugar, it will be seen that those sirups containing the largest amounts of glucose are those generally showing the widest difference between analytical and polariscopic results.

For example, the average of the entire number of sirups analyzed and polarized, thirty-eight in all, show by analysis 39.34 per cent. of sucrose, and by the polariscope 35.82 per cent., or 91.05 per cent. of the analytical result; while, taking the eight poorest sirups, the average by analysis is 27.54 per cent. of sucrose, and by the polariscope only 19.76 per cent., or 71.75 per cent. of the analytical result.

If we examine the juices obtained from the sorghums received from Mr. Golden, September 27, 28, and 30, and October 3 and 4, we shall find a very surprising and abnormal condition existing, which is worthy careful consideration. These results are as follows:

Juices from sorghums grown by Golden.

Dates.	Polarization.	Sucrose.	Glucose.	Specific gravity.	Solids.
September 27	.07	3.75	10.85	1.063	2.80
	.00	3.66	11.69	1.069	2.07
September 28	.00	2.30	13.25	1.070	2.48
September 30	1.04	5.16	10.78	1.072	2.53
October 3	1.05	2.62	10.45	1.059	2.41
October 4	.70	2.67	11.94	1.067	1.51
Average	.48	3.36	11.49	1.067	2.47

We have, then, as the average of the six juices an amount of sucrose as indicated by the polariscope only 14.3 per cent. of the amount shown to be present by analysis. We have also a specific gravity of 1.067, which, as will be seen by consulting the analytical tables of these sorghums in 1880 and 1881, indicates, as the average of a large number of analyses of normal juices, a juice of the following composition, viz:

	Per cent.
Specific gravity	1.067
Sucrose	11.80
Glucose	1.99
Solids	2.87

It will be seen that this composition closely resembles the average of the above six, except in this, that the sucrose and glucose appear to have changed places, the sum of the two being in one case 13.79 per cent. and in the other 14.85 per cent.

Now, in over 4,000 separate analyses of sorghum juices from canes recently cut, there has never been found even one which approximated the composition of the average of these six juices above given.

In no case has the polariscope approximately differed so widely from the results of analysis as in these, for, as will be seen by a previous table, the average results of the polariscope, as compared with the results of analyses of all the juices analyzed, gave 96 per cent. of the analytical result, while these contain but 14.3 per cent. The conclusion, then, is irresistible that these juices are wholly abnormal, and are so through the inversion of the sucrose which existed in the plant, since, as has been shown, the average of all the analyses made have demonstrated that if the total of glucose and sucrose in a juice is 14 or 15 per cent. of the juice, at least 12 or 13 per cent. of this had existed in the plant as sucrose, and, if not present upon analysis, it must have suffered inversion, as in this case was easily rendered probable by the stalks having been cut some days before they were worked up in the mill.

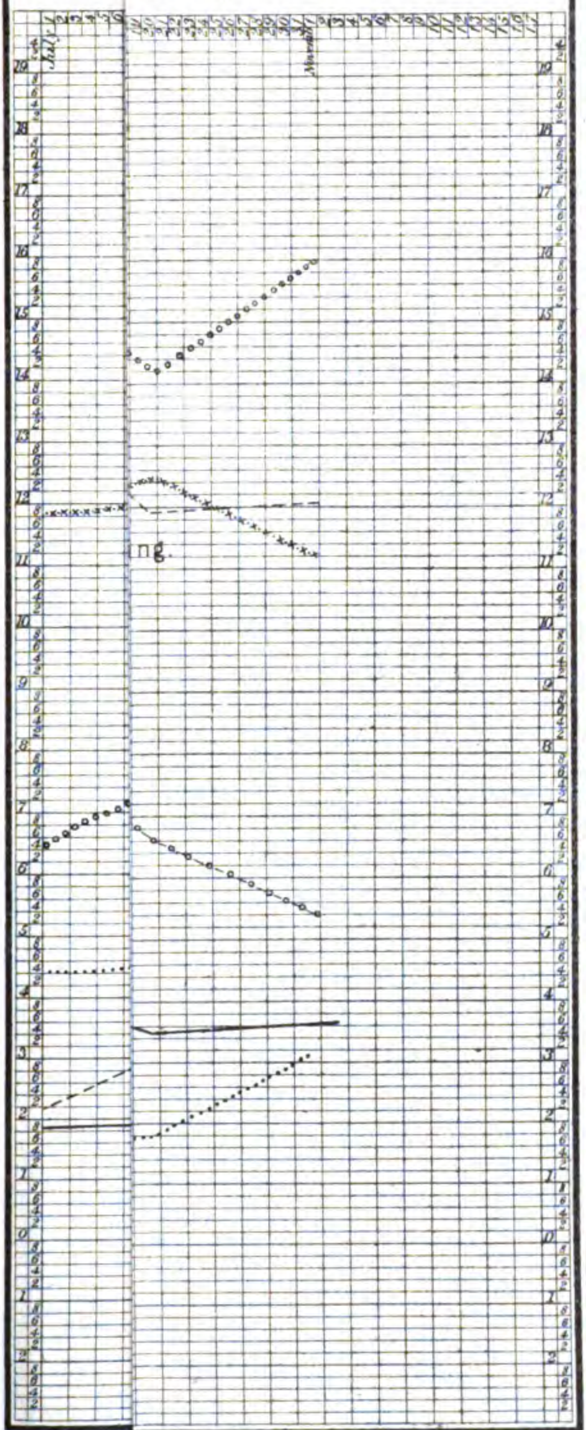
EXPERIENCE OF DR. C. A. GOESSMANN WITH SORGHUM CUT SOME TIME BEFORE WORKING.

Dr. Goessmann, of the Massachusetts Agricultural College, in his report of experiments upon the Early Amber Sorghum, gives a similar series of results of analyses of juices entirely comparable with those just given. (*Vide* report on "Early Amber Cane, by Prof. C. A. Goessmann, 1879.") His results are so valuable, as fully confirming our own, and establishing the fact that what has been found true during the past four years in this latitude is equally true in Massachusetts, viz., that certain of the varieties of sorghum may, even in that high latitude, attain a content of sugar fully equal to that of the sugar cane of the tropics, that his analytical results of examination are here appended. Of these there were but eighteen complete results, and for purpose of comparison the results here attained of the average of juices, having the same specific gravity as those analyzed by Dr. Goessmann, are given in the table alongside. It will be observed that the results attained by him from August 15 to September 18, inclusive, are almost identical with our own, showing from the first a gradual increase in the sugar.

Comparison of results obtained by Dr. Goessmann, at Amherst, Massachusetts, with those obtained at the Department of Agriculture.

1878.	Goessmann.				Collier.				No. of analyses.
	Sucrose.	Glucose.	Specific gravity.	Total sugar.	Total sugar.	Sucrose.	Glucose.	Specific gravity.	
Aug. 15	0.00	2.48	1.017	2.48	....	....	....	....	....
16	0.00	4.06	1.023	4.06	4.42	1.15	3.27	1.023	3
20	2.15	3.47	1.032	5.62	6.11	2.16	3.95	1.032	17
24	3.00	3.70	1.035	6.70	7.40	3.29	4.41	1.035	23
27	4.13	3.65	1.040	7.78	8.35	4.41	3.94	1.040	18
30	3.81	4.00	1.038	7.81	7.86	3.43	4.43	1.038	21
Sept. 2	4.41	3.85	1.043	8.26	9.21	4.95	4.26	1.043	22
9	6.86	3.21	1.048	10.07	10.07	6.08	3.99	1.048	36
9	6.81	3.77	1.052	10.58	10.82	7.64	3.18	1.052	43
18	7.65	3.57	1.054	11.22	10.86	7.74	3.12	1.054	49
18	8.49	3.16	1.056	11.65	11.57	8.61	2.96	1.056	52
18	5.85	3.16	1.046	9.01	9.48	5.72	3.76	1.046	30
18	.60	10.00	1.052	10.60	10.82	7.64	3.18	1.052	43
21	....	....	1.053	....	11.00	7.58	3.42	1.053	43
23	....	....	1.061	....	12.61	9.88	2.73	1.061	76
29	8.16	3.61	1.060	11.77	12.45	9.80	2.65	1.060	100
Sept. 25	6.27	11.91	1.082	18.18	16.20	15.06	1.14	1.082	25
26	....	....	1.060	....	12.45	9.80	2.65	1.060	100
28	Not det'd.	16.60	1.073	....	14.68	12.83	1.85	1.073	75
Oct. 1	....	....	1.072	....	14.62	12.94	1.68	1.072	82
3	....	....	1.061	....	12.61	9.88	2.73	1.061	76
4	6.16	8.62	1.066	14.78	13.54	11.46	2.08	1.066	74
7	9.94	4.16	1.069	14.10	14.11	12.30	1.81	1.069	75
8	5.27	5.16	1.052	10.43	10.82	7.64	3.18	1.052	43
9	Not det'd.	7.57	1.076	....	15.13	13.66	1.47	1.076	68
10	....	....	1.062	....	12.75	10.24	2.51	1.062	73
11	....	....	1.070	....	14.43	12.59	1.84	1.070	82
14	Not det'd.	10.42	1.075	....	15.18	13.47	1.71	1.075	67
15	....	....	1.062	....	12.75	10.24	2.51	1.062	73
16	....	....	1.071	....	14.35	12.54	1.81	1.071	80
17	....	....	1.074	....	14.91	13.22	1.69	1.074	75
18	Not det'd.	7.57	1.061	....	12.61	9.88	2.73	1.061	76
19	Not det'd.	9.22	1.063	....	12.81	10.16	2.65	1.063	84
20	....	....	1.071	....	14.35	12.54	1.81	1.071	89
22	Not det'd.	8.30	1.067	....	13.79	11.80	1.99	1.067	80
23	5.50	11.30	1.075	16.80	15.18	13.47	1.71	1.075	67
24	Not det'd.	8.63	1.068	....	13.81	11.84	1.97	1.068	56
						247.56	43.52		
				Average	of (21)	11.79	2.07		

Analyses 2718.



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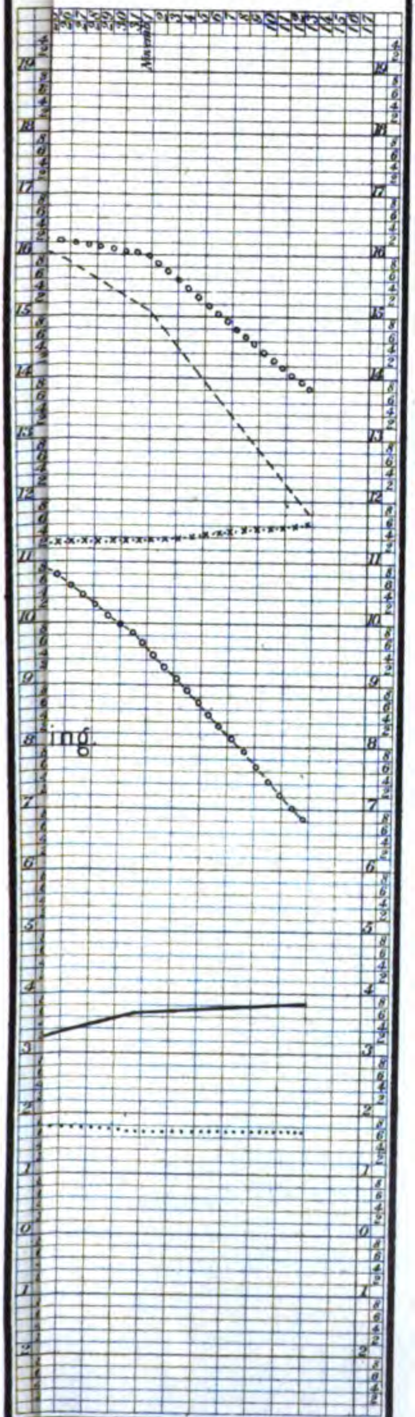
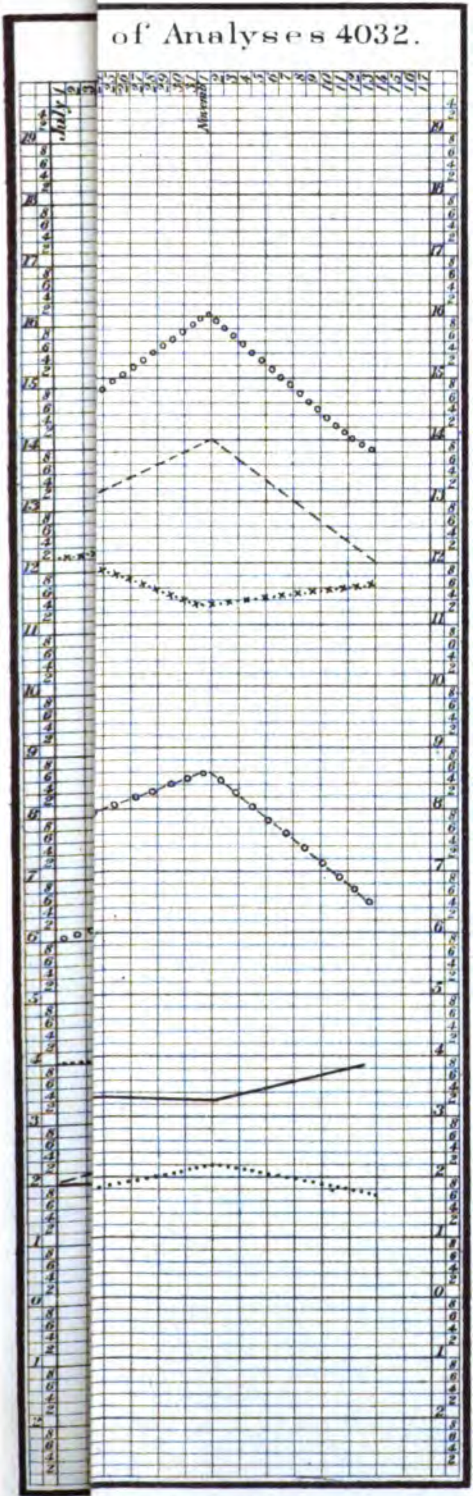


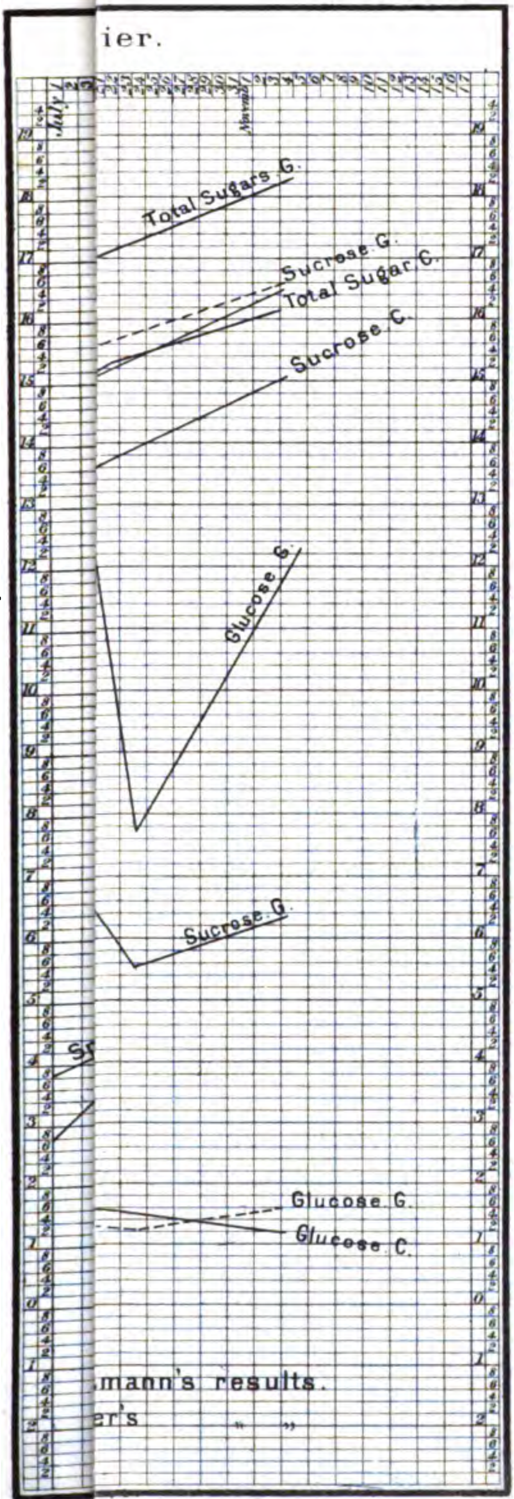
Available Sugar.

of Analyses 4032.



-Available Sugar.

Plate XXI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July
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Total Sugars G.
Sucrose G.
Total Sugar C.
Sucrose C.
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After the first analysis under date September 18, the results, as will be seen, are widely different. In explanation of this Dr. Goessmann has given ample reason in his report accompanying these analyses. In regard to these early analyses (before September 18) he says the juice from the freshly-cut canes grown upon the grounds of the Agricultural College was "treated without delay"; and of those subsequent to September 18 he says: "A part of our cane after being cut was left upon the field for about ten days before being ground and pressed." He says that the results of these experiments "admit of no other explanation, but that the best course to pursue consists in grinding the matured cane as soon as it is cut."

In regard to the remainder of the experiments recorded by him, he says:

Some of the cane sent on (by farmers growing it near the college) was ground soon after it had been cut; other lots had been cut weeks before their turn in the mill came round.

It will be observed, then, that only those analyses made previous to September 18 are of freshly-cut cane, and these analyses fully agree with the average of our results with all the varieties of sorghum experimented with.

It will be observed, also, that just as he found in those canes which were brought in some days, or even weeks, after they had been cut, so too, our results show the inversion of a large amount of sugar; and, except in the sum of the sugars present in the juices, these results are not at all comparable with those secured by analyses of juices of the same specific gravity from freshly-cut canes. It will also be of interest to remember that the last examinations made by Dr. G. of the canes grown under his supervision were made only nine days after he describes the "seeds as still soft," and by reference to the previous tables it will be seen that during each of the past four years we have found that it is just at this period of development of the plant that the sugar in the juice becomes practically available, and that thereafter it rapidly increases in quantity. In order to show more clearly the close agreement of our results with those of Dr. Goessmann, his results have been platted upon the following chart, and with them the average results of our examinations (the number of which analyses are given) of juices having the same specific gravity as those analyzed by him. The line A B limits the analyses made by him of stalks grown by the college. The very closé agreement of sucrose and glucose between our results and his own up to this period is very manifest, as also the wide differences immediately after, except in the total sugars present in the juice. The dotted lines show where the lines of glucose and sucrose would have gone, by estimating the relative amount of glucose and sucrose present in the average of all the juices which have been analyzed by us, having the same amount of total sugars as were shown by Dr. Goessmann's analyses. The close agreement of these dotted lines with the results of actual analyses, many hundreds in number, made by us, show beyond question that in those juices analyzed by Dr. G. after September 18, a large portion of the sucrose had been inverted.

COMPARTIVE RESULTS, SUCKERED AND UNSUCKERED SORGHUMS.

It has been already stated that the plat of sorghums grown upon the grounds of the department was divided into two portions, one portion of which was carefully kept free from suckers, and the other portion, after having been thinned out like the former, was allowed to send up any suckers which would grow.

The following table shows the results of the two methods of culture, so far as the available sugar is concerned, and also the results of analyses of the juices of the same kinds of sorghums grown by Mr. Golden and Mr. Green. There is also appended the examination of several varieties of maize grown upon the department grounds and by Mr. Dean, as also the result of analyses of maize stalks sent by Mr. McMurray, of Frederick, Md. It will be seen that the average available sugar from the thirty-four varieties of sorghum which were suckered was 8.29 per cent. of the juice, while from the unsuckered plat the average of thirty-seven varieties was only 5 per cent. of the juice. Also, that while the former gave sirups averaging in available sugur 32.17 per cent. of their weight, the latter gave sirups averaging in available sugar only 18.71 per cent. of their weight, or 58.2 per cent. of the former. It will also be remembered that the amount of stalks grown per acre was practically the same whether the crop had been suckered or not. Also, that the suckered portion had been during the season culled of exactly one-sixth of its weight of stalks for purpose of analysis, and that these stalks, after being cut, sent up numerous suckers, which really lowered the average per cent. in available sugar which would have been otherwise attained.

It will be seen that of the sixteen varieties grown by Mr. Golden only one gives any available sugar, and that one less than 2 per cent., while the average of the entire sixteen gives minus 5.27 per cent., and of the eleven sirups made from these juices not one gives any available sugar, the average result of the eleven being minus 23.60 per cent. These results which differ so widely from those obtained in the examination and working of these same varieties grown upon the department grounds, are, however, similar to the results obtained by Dr. Goessmann in his examinations of canes grown by the neighboring farmers; and in each case the cause of these unfavorable results is manifest, viz., the want of promptness in working up the canes after they were cut. To this sufficient cause must be superadded, in the case of some of the canes of Mr. Golden, the very unfavorable effects of frost upon those last worked from his plat.

Per cent. of available sugar in juices of sorghums and maize.

No.	Varieties.	Department grounds.				Golden.		Green.	
		Suckered.		Unsuckered.					
		Juice.	Sirup.	Juice.	Sirup.	Juice.	Sirup.	Juice.	Sirup.
1	Early Amber	10.87		12.05		—9.90		2.89	17.32
2	Early Golden	10.63		12.76		—10.10	—45.50		
3	White Liberian	11.20		9.61		—13.43	—35.72	2.49	18.66
4	......do	10.27		7.38	28.16		—68.60		
5	Black Top	8.10		.09		—1.49			
6	African	7.81	35.90	2.22		—.65			
7	White Mammoth	9.70		8.51	23.90				
8	Oomseeana	8.18		1.84		—7.27	—28.40		
9	Regular Sorgho	5.45		—1.05	16.19	—9.68	—45.78		
10	Link's Hybrid	15.49		7.58				1.09	6.38
11	......do	13.10		9.10	21.56				
12	Sugar Cane	12.84		7.70					
13	Goose Neck	7.26		—.01	6.26	—1.67	—12.20		
14	Bear Tail	7.10		3.16		—2.98	—2.50		
15	Iowa Red Top	9.91	35.18	5.97	35.12	—2.24	—11.34		
16	New Variety	9.52		8.02		—3.84			
17	Early Orange	9.62		4.76					
18	......do	9.23		10.19					
19	Orange Cane	9.26		5.18					
20	Neeazana	6.95		3.42	18.30			4.07	11.28
21	Wolf Tail	10.03		6.26					
22	Gray Top	6.56							

Per cent. of available sugar in juices of sorghums and maize—Continued.

No.	Varieties.	Department grounds.				Golden.		Green.	
		Suckered.		Unsuckered.					
		Juice.	Sirup.	Juice.	Sirup.	Juice.	Sirup.	Juice.	Sirup.
23	Liberian	1.97	87.40	.78	6.36	....	....	— 2.06	—10.70
24	Mastodon	5.88	....	.93	....	....	....	....	....
25	Honduras	.50	....	— .33	4.60	....	....	— 4.40	—30.42
26	Sugar Cane	4.30	....	— .61	....	— .65	— 5.68	....	....
27	Wallis Hybrid	.23	....	— 1.55	....	— .99	— .04	....	....
28	White Imphee	9.91	....	.82	....	....	....	....	....
29	Goose Neck	6.34	20.20	— 2.67	....	....	....	....	....
30	White African	7.57	....	6.22	25.06	....	....	....	....
31	West India	9.96	....	4.81	....	....	....	....	....
32	Sugar Cane	6.55	....	1.89	....	....	....	....	....
33	New Variety	9.53	....	5.52	....	....	....	....	....
34	Early Amber	9.93	....	9.40	....	....	....	1.59	14.92
35	Holcus Saccharatus	....	....	— .94	....	....	....	....	....
37	Holcus Cernus	....	....	9.70	....	....	....	....	....
38	Honey Cane	....	....	6.71	20.34	....	....	....	....
42	Honduras	....	....	....	....	—10.30	....	....	....
50	Neeazana	....	....	....	....	1.85	....	....	....
51	Liberian	....	....	....	....	— 9.12	— 8.82	....	....
	Average	8.29	32.17	5.00	18.71	— 5.27	—23.60	1.73	9.8

INVERSION OF SUGAR IN CUT CANES.

The effects of this inversion of sugar, due to allowing the cut canes to remain sometime before working, will be seen in the following results with three varieties grown on the department grounds and promptly worked; these same varieties grown by Mr. Golden and not promptly worked; and three of the results of Dr. Goessmann, of which three he reports that the first analysis was of canes, which, "after being cut, were left for three weeks upon the field," the second analysis of "cane several weeks old when ground," the third analysis, of canes topped, cut up, and "left upon the field nine days." These are the only cases mentioned in his report in which the time is given during which the canes, after being cut up, remained unworked.

The close agreement of results attained with those from Mr. Golden's canes is obvious, and the great difference between these and the results from canes promptly worked up show the great importance of this matter to those hoping for good results in the production of sugar.

Inversion of sugar by canes not being worked promptly.

Varieties.	Department ground.				Mr. Golden.				Dr. Goessmann.			
	Specific gravity.	Sucrose.	Glucose.	Total sugars.	Specific gravity.	Sucrose.	Glucose.	Total sugars.	Specific gravity.	Sucrose.	Glucose.	Total sugars.
Early Amber	1.087	16.06	1.38	17.44	1.063	3.75	10.85	14.60	1.082	6.27	11.91	18.18
Early Golden	1.088	15.93	1.37	17.30	1.069	3.66	11.69	15.35	1.075	(?)	10.42	. .
White Liberian	1.083	16.03	1.37	17.40	1.070	2.30	13.25	15.55	1.052	.60	10.00	10.60

The average of the seven varieties grown by Mr. Green is only 1.73 per cent. of available sugar in the juice, and, as will be seen, two of the seven give a negative result.

These two varieties are the latest in maturing, and as he planted quite late (May 27), the frost, which came before any of his cane was worked, affected as we have already seen, the more immature canes most injuriously.

EFFECT ON JUICE OF STANDING AFTER DEFECATION.

In the daily work of the small mill it became frequently desirable to keep a supply of juice over night, and it was found that, after defecating as usual with lime and heat, the juice could remain in the defecator without suffering any detriment. As this is a matter of considerable practical importance in working up large quantities of juice, especially if the work is not carried on through the night, by enabling one to have a fresh lot of juice for the evaporator early in the morning, the following results of these experiments are given, including the analyses of juice before defecation and after standing over night in the defecator, of the sirups produced, and of the percentage of sugar present in the juice and obtained in the sirup. It will be seen that the results show no effects fairly to be charged against this mode of procedure.

It will be seen that in the experiment of October 3 there is apparently a loss of more than half the sugar. This may be due to an error in weighing the sirup, and probably is, since it is altogether exceptional, the average of the entire 40 experiments showing a saving of 87.5 per cent. of the sugar present in the juice.

Effect on juice of standing after defecation.

Experiment number.	Date.	Pounds juice.	Time in defecator.	Pounds water added.	Per cent. sucrose by polarization.	Per cent. of glucose in sirup.	Per cent. of sucrose in sirup.	Per cent. of solids not sugar in sirup.
3	Sept. 14	627.5	17 hours	105	30.91	16.15	45.32	12.98
6	Sept. 15	770.5	14.5 hours	....	32.40	28.00	38.95	13.46
14	Sept. 27	712.5	14.5 hours	....	....	50.50 (?)	17.50 (?)	12.50 (?)
16*	Sept. 28	980	17 hours	....	8.67	59.00	9.50	19.10
19	Sept. 30	682	15.3 hours	126	36.05	18.00	38.00	15.40
22	Oct. 3	1,085.5	15.5 hours	....	14.58	41.75	22.14	4.51
23	Oct. 4	1,162.5	15.5 hours	....	24.71	37.00	30.50	5.70
26	Oct. 5	746	16 hours	....	35.23	34.40	36.39	12.21
29	Oct. 7	728.5	14 hours	....	55.40	6.50	59.85	17.45

Experiment number.	Date.	Analysis of juice.			Analysis of juice after defecation.			Per cent. sucrose of juice in sirup.	Per cent. glucose of juice in sirup.
		Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.		
3	Sept. 14	....	....	....	....	....	....	98.7	96.5
6	Sept. 15	....	....	....	....	....	....	98.5	78.3
14	Sept. 27	....	....	....	....	....	....	80.6	77.7
16*	Sept. 28	....	....	....	....	....	....	....	....
19	Sept. 30	....	....	....	....	....	....	75.5	71.8
22	Oct. 3	8.92	3.32	3.46	9.80	4.64	1.02	44.4	31.1
23	Oct. 4	7.10	7.26	1.19	8.40	7.43	1.72	80.1	99.4
26	Oct. 5	6.01	6.95	1.59	6.91	7.12	2.05	76.0	83.1
29	Oct. 7	1.79	14.29	3.64	1.84	14.73	2.60	69.9	69.7

*In Experiment No 16 the sirup was added to an equal amount made by evaporation directly after defecation.

EFFECT OF ADDING WATER TO JUICE DURING DEFECATION.

It frequently happened in our experiments in working up the canes from the department ground, owing to the great specific gravity of the juices, from 1.075 to 1.090 (10° to 12° Baumé), that in the defecation the precipitate formed by the addition of lime, would fail to subside and remain permanently suspended in the defecated juice. Since it was found upon trial that this precipitate was during the process of evaporation but partially brought to the surface as scum, and remained in the sirup, giving it a disagreeable appearance and taste, the experiment was made of diluting the juice after defecation by adding buckets of cold water, and it was found to work with entire satisfaction, and necessitated only the removal of this additional amount of water by evaporation.

The following table gives the results of fourteen experiments, which show that there was no loss of sugar involved by this operation. The average amount of water added equaled 16 per cent. of the juice, but the amount added varied with the density of the juice operated upon.

Effect of adding water to juice during defecation.

Number of experiment.	Date.	Pounds of juice.	Pounds water added.	Per cent. of sucrose in sirup by polarization.	Per cent. of glucose in sirup.	Per cent. of sucrose in sirup.	Per cent. of solids in sirup.	Per cent. of sucrose of juice in sirup.	Per cent. of glucose of juice in sirup.
8	Sept. 16	425	63	43.74	18.00	50.35	8.45	95.2	90.2
9	Sept. 17	592.5	210	43.42	7.20	47.98	19.22	97.2	116.2
10	Sept. 17	557.5	168	41.88	10.00	48.23	26.97	88.5	74.8
13	Sept. 27	800.5	168	42.85	10.25	44.15	15.60	78.6	70.1
17	Sept. 29	640.5	168	45.85	20.50	46.08	19.22	80.5	105.2
18*	Sept. 30	884.5	126	30.94	28.20	38.29	13.91	119.4	69.9
20	Oct. 1	1,045.5	105	19.20	38.20	19.76	14.24	64.0	118.6
21	Oct. 3	1,133.5	105	12.96	45.75	17.39	12.26	78.2	80.5
24	Oct. 4	1,055	105	5.43	49.50	14.73	16.17	122.8	92.4
28	Oct. 7	1,308	147	51.19	14.35	53.87	19.18	80.5	71.1
30	Oct. 8	905.5	126	59.50	7.00	59.09	16.91	93.3	102.8
31	Oct. 10	832.5	147	54.50	9.00	58.90	12.50	90.2	70.7
32	Oct. 11	489	63	45.28	12.50	45.60	12.90	85.8	74.8
35	Oct. 18	780	84	46.98	22.65	48.36	10.79	92.1	74.1

*In Experiment No. 18 the diluted juice was added to about one-half its bulk of undiluted juice, and then evaporated.

EXPERIMENTS IN DEFECATION.

Besides the many experiments in defecation of sorghum juices which were made at the "small mill," and which are given in detail in another portion of this report, there were also made during the season a very large number of experiments in the laboratory with comparatively small quantities of juice, for the purpose of learning the effects of various defecating agents, especially lime, sulphurous acid, and sulphite of lime.

The results of many of these experiments are given in the following table, as being chiefly valuable to those who may desire to continue investigations in the same direction.

In each case a sample of juice was analyzed as usual, and then separate portions of this juice were submitted to different modes of treatment, and the resulting products were in each case fully examined, and the gain or loss of sucrose, glucose, and solids resulting from the several methods of defecation were thus shown.

DEFECATION EXPERIMENTS.

Number of juice.	Number of experiment.	Specific gravity.	Percentage of glucose.	Percentage of sucrose.	Percentage of solids not sugar.	Total solids.	In total solids. Percentage of glucose.	In total solids. Percentage of sucrose.	In total solids. Percentage of solids not sugar.	Remarks.
505	Juice	1.059	2.72	10.56	2.06	15.34	17.73	68.84	13.43	
527	1	1.061	2.47	9.78	3.11	15.36	16.08	63.67	21.15	20 hours cold + 10 grams per liter $CaSO_3$. Filtrate dark amber.
528	2	1.059	3.55	8.63	3.11	15.29	23.22	56.44	20.34	5 grams per liter $CaSO_3$, heated to 80° C., filtered. Next morning odor of H_2S.
529	3	1.059	3.27	8.11	3.06	14.44	22.65	56.16	21.19	Passed SO_2 from 20 grams $CaSO_3$ into 1 L. juice; bleached yellow, filtered.
530	4	1.059	3.54	8.07	3.68	15.29	23.15	52.78	24.07	Stood alone over night; soured; heavy precipitate. Filtrate light amber.
517	Juice	1.054	3.63	8.54	1.59	13.70	26.50	62.34	11.16	
531	5	1.052	2.61	7.90	3.46	13.97	18.68	56.55	24.77	Heated to 77° C. and filtered. Filtrate light amber; good defecation.
532	6	1.053	2.75	7.98	3.23	13.96	19.70	57.16	23.14	Heated to boiling; better defecation than Experiment 5; filtrate lighter.
533	7	1.057	1.92	7.77	4.21	13.90	13.81	55.90	30.29	Added one per cent. CaO; stood cold 30 minutes. Filtrate orange.
534	8	1.053	.59	9.81	3.03	13.43	4.39	73.05	22.56	Added one per cent. CaO; heated nearly to 100°. Filtrate dark molasses color.
535	9	1.054	3.67	4.88	5.20	13.75	26.69	35.49	37.82	Used excess SO_2, heated to 82° C. Filtrate pale yellow. Good defecation.
536	10	1.052	2.60	7.67	3.32	13.59	19.13	56.44	24.43	4–5 L. juice, made moderately alkaline, 85° to 90° C., and filtered.
546	Juice	1.058	2.71	9.76	2.84	15.31	17.70	63.75	18.55	
547	11	1.041	4.74	4.06	2.53	11.33	41.84	35.92	12.24	Juice from Experiment 9 boiled to light-colored sirup, to show *relative* results.
548	12	1.053	3.79	7.44	2.73	13.96	27.15	53.30	19.55	Lost, by broken flask.
549	13	1.053	3.23	8.43	2.30	13.96	23.14	60.39	16.47	Juice No. 546 simply filtered cold. Filtrate light amber.
550	14	1.051	3.15	8.04	2.36	13.55	23.25	59.34	17.41	Heated juice from Experiment 13 to 86°. Coagulation of albumen.
551	15	1.058	4.10	8.17	1.72	13.99	29.82	58.40	11.78	Filtered juice from Experiment No. 13 treated with SO_2, and allowed to stand 20 hours.
552	16	1.056	5.48	6.27	1.98	13.73	39.91	45.67	14.41	300 c. c. from Experiment 13 boiled to sirup, again diluted to 300 c. c. and analyzed.
563	Juice	1.054	4.05	7.41	3.72	15.18	26.68	48.81	24.51	
564	17	1.053	4.16	7.33	3.56	15.05	27.64	48.70	23.64	Juice No. 563 filtered cold.
565	18	1.051	3.93	7.84	2.55	14.32	27.44	54.75	17.81	Exactly neutralized with $Ca(OH)_2$ cold; filtered from white precipitate.
566	19	1.051	4.40	7.79	2.74	14.93	29.47	51.51	19.02	Filtered from Experiment 18 boiled, and albumen filtered out.
567	20	1.048	4.17	6.95	2.33	13.45	31.00	51.67	17.33	Evaporated 200 c. c. to sirup; diluted to 200 c. c., filtered and analyzed.
588	Juice	1.053	3.92	7.12	3.91	14.95	26.22	47.62	26.16	
606	21	1.069	4.27	10.39	2.41	17.07	25.01	60.86	14.13	Juice 588 defecated by exactly neutralizing by Ca(OH); filtered, evaporated to sirup, diluted, and analyzed.
605	22	1.057	4.55	8.49	1.52	11.66	31.03	57.91	11.06	Filtered juice from Experiment 21, analyzed August 9. (Stood over night.)
608	23	1.040	3.87	7.87	.74	....	....	....	....	Juice from Experiment 22, faintly alkaline by $Ca(OH)_2$, boiled to sirup, diluted, and analyzed.
604	Juice	1.055	3.52	9.50	.91	13.93	25.27	68.19	6.54	
607	24	1.084	5.08	10.36	4.16	19.60	25.40	52.85	21.75	7 liters juice 604, + 35 grams CaO, defecated at 100° C. Evaporated to sirup, diluted, and analyzed.

SPECIFIC GRAVITY TABLES OF JUICES OF SORGHUM AND MAIZE.

In the following tables the average results in percentage of juice obtained, the percentage of the several constituents of the juice, the available sugar calculated as the difference between the sucrose and the sum of the solids not sucrose, the exponent of purity, by which is meant the percentage of sucrose in the total solids of the juices, and the available sugar calculated from this "exponent," as also the number of analyses made, is shown for each degree of specific gravity.

There is also given in the tables for maize and sorghum of 1881 the average polarization of the several juices.

If we include all of the analyses of maize juices in which the specific gravity exceeded 1.055 for 1880, it will be seen that there were made in all 118 analyses, with the following average results:

Average results for maize, 1880.

	Per cent.
Juice obtained	53.43
Sucrose in juice	11.30
Glucose in juice	1.01
Solids not sugars in juice	4.12
Available sugar = sucrose — (glucose + solids)	6.17
Exponent	6.88
Available sugar calculated by exponent	7.77

Number of analyses, 118.

Average results for maize, 1881.

[Juices above 1.055 specific gravity.]

	Per cent.
Juice obtained	54.60
Sucrose in juice	11.72
Glucose in juice	2.27
Solids not sugars in juice	2.39
Polarization	10.86
Available sugar = sucrose — (glucose and solids)	7.06
Exponent	71.6
Available sugar calculated by exponent	8.39

Number of analyses, 28.

From the above results it will be seen that the available sugar from one ton (2,000 pounds) of maize stalks was, in 1880, by exponent method of estimation, 83 pounds, a difference between sucrose and other solids of 66 pounds; in 1881, from 2,000 pounds stalks, by exponent, 92 pounds, a difference of 77 pounds between sucrose and other solids.

It will be observed that the results by polarization of the above maize juices in 1881 was 92.6 per cent. of the results obtained by analysis.

Average results for sorghum, 1880.

[Juices above 1.065 specific gravity.]

	Per cent.
Juice obtained	60.22
Sucrose in juice	13.85
Glucose in juice	1.64
Solids not sugars in juice	3.85
Available sugar by difference	8.36
Exponent	71.7
Available sugar by exponent	9.93

Number of analyses, 1,127.

Average results for sorghum, 1881.

[Juices above 1.065 specific gravity.]

	Per cent.
Juice obtained	58.51
Sucrose in juice	15.29
Polarization	14.34
Glucose in juice	1.62
Solids not sugars in juice	3.55
Available sugar by difference	10.12
Exponent	74.7
Available sugar by exponent	11.42

Number of analyses, 591.

From the above results it will be seen that the available sugar from one ton (2,000 pounds) of sorghum was, in 1880, by exponent, 120 pounds; by difference, 101 pounds. In 1881, by exponent, 134 pounds, a difference of 118 pounds.

It will be observed, also, as in the case of the maize juices in 1881, that the results by polarization are 93.8 per cent. of those obtained by analysis.

SPECIFIC GRAVITY TABLES

MAIZE JUICES, 1880.

Specific gravity.	Per cent. of juice.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids.	Per cent. of available sugar.	No. of analysis.
1.019	37.83	1.19	1.95	1.13	−.37	1
1.020	....	....	....	....	....	....
1.021	47.52	.34	1.77	.....	....	1
1.022	54.97	.09	1.23	2.25	−1.11	1
1.023	45.96	.61	1.72	2.26	−1.15	1
1.024	....	....	....	....	....	....
1.025	65.26	.76	3.21	2.17	.28	1
1.026	63.06	.72	2.64	2.74	−.82	2
1.027	58.78	.85	3.71	2.10	.76	2
1.028	55.75	1.93	3.39	2.02	−.56	1
1.029	....	....	....	....	....	....
1.030	....	....	....	....	....	....
1.031	64.53	1.26	3.32	2.37	−.31	3
1.032	61.93	1.51	3.16	2.31	−.66	1
1.033	63.29	1.46	4.53	2.29	.78	2
1.034	64.05	1.05	4.88	2.48	1.35	1
1.035	64.47	1.15	4.37	2.24	.98	2
1.036	....	....	....	....	....	....
1.037	52.60	1.20	4.73	3.00	.53	3
1.038	58.65	1.99	4.79	2.23	.57	2
1.039	67.75	.42	6.16	3.00	2.74	1
1.040	61.42	1.32	6.24	2.43	2.49	3
1.041	59.57	1.45	6.20	2.59	2.16	7
1.042	57.58	1.80	5.90	2.62	1.58	4
1.043	62.94	1.80	6.85	1.94	2.61	2
1.044	60.32	1.95	6.71	1.76	3.00	2
1.045	60.97	1.82	7.17	1.90	3.45	2
1.046	61.67	1.80	7.72	2.04	3.88	3
1.047	58.52	1.32	8.17	2.75	4.10	7
1.048	56.55	1.81	7.08	2.80	2.47	4
1.049	63.57	1.08	7.96	2.92	3.96	3
1.050	63.63	1.02	9.18	1.74	6.42	2
1.051	....	....	....	....	....	....
1.052	59.75	1.66	8.95	2.83	4.46	2
1.053	55.35	1.43	9.13	2.56	5.14	4
1.054	57.30	1.76	8.01	3.51	2.74	4
1.055	47.81	1.04	9.13	3.61	4.48	4
1.056	55.02	1.00	9.58	2.81	5.77	3
1.057	56.71	1.28	9.02	3.65	4.09	11
1.058	57.29	1.33	9.49	2.75	5.41	5
1.059	58.89	1.36	9.85	3.99	4.50	8
1.060	53.45	.95	9.61	4.12	4.54	6
1.061	55.60	1.27	10.02	3.73	5.02	8
1.062	56.81	1.05	10.87	3.51	6.28	11
1.063	53.13	.93	10.27	3.78	5.56	6
1.064	52.55	.99	11.05	3.96	6.10	8
1.065	54.81	1.26	10.98	3.73	5.99	12
1.066	49.63	.93	10.81	4.10	5.78	6
1.067	46.93	1.12	11.33	4.21	6.00	6
1.068	57.20	.82	12.45	3.84	7.79	7
1.069	58.87	.60	12.54	4.39	7.55	1

SPECIFIC GRAVITY TABLES—Continued.

MAIZE JUICES, 1880—Continued.

Specific gravity.	Per cent. of juice.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids.	Per cent. of available sugar.	No. of analyses.
1.070	48.27	.86	11.99	4.35	6.78	2
1.071	56.11	1.14	11.77	4.42	6.21	3
1.072	50.25	.77	12.14	4.43	6.94	4
1.073	49.76	1.12	12.95	3.04	8.79	3
1.074	58.90	.91	11.49	5.83	5.75	8
1.075	47.69	1.20	11.01	5.72	4.09	2
1.076	39.47	.68	11.45	6.18	4.59	1
1.077	57.63	.71	13.99	4.91	8.37	1
1.078	....	....	....	....	....	....
1.079	55.11	.89	15.16	3.27	11.00	1

MAIZE JUICES, 1881.

Specific gravity.	Per cent. of juice.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugars.	Per cent. of polarization.	Per cent. of available sugar.	No. of analyses.
1.014	69.10	1.17	.47	1.52	....	−2.22	1
1.015	75 75	1.69	.32	1.39	....	−2.76	2
1.016	65.70	1.36	.30	1.94	....	−3.00	3
1.017	68.28	2.02	.24	2.06	....	−3.84	4
1.018	63.90	2.08	.27	2.37	....	−4.18	4
1.019	65.92	1.89	.55	3.14	....	−4.48	3
1.020	63.39	2.77	.38	3.40	....	−5.79	4
1.021	65.83	2.55	.60	2.26	....	−4.21	4
1.022	66.39	3.35	.49	2.66	....	−5.52	4
1.023	62.70	3.10	.86	2.93	....	−5.17	6
1.024	65.43	2.53	1.50	2.85	....	−3.88	7
1.025	65.61	2.92	1.04	2.83	....	−4.71	6
1.026	66.97	3.10	1.04	3.11	....	−5.17	2
1.027	57.34	1.93	2.14	3.20	....	−2.99	3
1.028	60.76	2.93	1.50	3.31	....	−4.74	6
1.029	60.61	2.71	2.45	2.53	2.17	−2.79	9
1.030	56.57	2.54	4.31	2.38	3.24	− .61	6
1.031	57.51	2.91	2.69	2.76	2.08	−2.98	2
1.032	59.42	2.92	3.07	2.80	2.80	−2.65	4
1.033	58.62	3.30	2.82	2.51	2.29	−2.99	3
1.034	60.16	3.21	3.68	2.62	3.66	−2.15	3
1.035	51.00	2.41	4.08	2.65	3.45	− .99	6
1.036	56.95	2.98	3.76	2.95	4.53	−2.17	5
1.037	55.17	2.60	4.47	2.96	4.25	−1.09	4
1.038	61.47	3.07	4.16	1.63	3.72	− .54	3
1.039	56.33	2.51	5.50	2.11	5.08	.88	7
1.040	62.63	2.79	4.82	2.77	5.05	− .74	7
1.041	57.47	2.74	5.49	2.24	5.00	.51	8
1.042	54.63	2.43	5.56	2.93	5.87	.20	4
1.043	61.46	3.03	5.16	2.90	5.44	− .77	4
1.044	56.68	2.71	6.57	2.83	5.99	.53	5
1.045	58.22	2.99	6.97	2.96	6.39	.12	6
1.046	61.34	2.85	6.64	2.82	6.16	.97	2
1.047	56.94	2.60	7.45	1.50	7.42	3.35	3
1.048	54.38	2.44	7.61	2.46	6.08	2.71	3
1.049	61.02	2.49	8.89	2.10	7.51	4.30	5
1.050	57.71	2.73	7.81	2.47	7.54	2.61	6
1.051	57.30	2.08	8.27	3.14	7.20	3.05	2
1.052	54.90	3.20	8.24	2.81	7.58	2.23	1
1.053	56.75	2.75	9.10	2.10	8.66	4.25	3
1.054	71.39	2.92	7.64	3.86	7.52	.86	1
1.055	57.18	2.78	9 18	1.99	6.91	4.41	3
1.056	53.72	2.39	10.88	2.51	9.46	5.98	2
1.057	62.36	1.68	11.21	1.76	10.22	7.77	3
1.058	55.47	2.54	10.45	2.19	10.25	5.72	2
1.059	58.78	2.27	11.01	1.76	10.52	6.98	2
1.060	58.31	2.12	10.62	2.44	10.58	6.06	3
1.061	56.07	1.99	11.92	1.85	10.65	8.08	5
1.062	53.49	2.30	11.44	3.46	11.39	5.68	4
1.063	....	....	....	....	....	....	....
1.064	53.14	1.29	12.94	1.88	12.37	9.77	1
1.065	53.90	2.05	11.92	2.36	11.40	7.51	2
1.066	....	....	....	....	....	....	....
1.067	53.11	1.44	13.88	2.86	....	9.58	1
1.068	....	....	....	....	....	....	....
1.069	51.47	2.25	12.55	2.50	11.74	7.80	1
1.070	....	....	....	....	....	....	....
1.071	50.14	5.41	9.91	3.35	....	1.15	1
1.072	....	....	....	....	....	....	....
1.073	54.89	1.75	13.59	2.19	....	9.65	1

SPECIFIC GRAVITY TABLES—Continued.

SORGHUM JUICES, 1881.

Specific gravity.	Per cent. of juice.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.	Per cent. of Polarization.	Per cent. of available sugar.	No. of analyses.
1.012	65.67	1.11	.26	3.17	………	—4.02	1
1.014	66.08	1.69	.43	2.66	………	—3.92	3
1.015	63.84	1.64	.64	2.56	………	—3.56	5
1.016	64.91	1.57	.26	2.27	………	—3.58	7
1.017	62.10	2.33	.43	2.50	………	—4.40	8
1.018	58.96	1.66	.66	2.19	………	—3.17	5
1.019	64.97	2.55	.46	2.79	………	—4.88	9
1.020	66.60	2.58	.90	3.10	………	—4.78	18
1.021	65.26	2.80	.49	3.25	………	—5.56	11
1.022	64.53	2.29	.99	3.20	………	—4.50	7
1.023	67.92	3.06	.94	3.92	………	—6.02	15
1.024	69.00	3.24	.80	2.72	………	—5.16	13
1.025	65.91	2.68	1.49	3.26	………	—4.45	13
1.026	68.25	3.21	1.61	2.39	………	—3.99	17
1.027	67.87	3.12	1.44	2.85	………	—4.53	14
1.028	67.37	3.55	1.38	3.66	………	—5.83	9
1.029	66.57	3.64	1.63	3.18	………	—5.19	11
1.030	65.89	2.88	2.12	2.45	1.78	—3.21	8
1.031	59.56	2.68	2.69	2.94	2.01	—2.93	6
1.032	68.27	3.89	1.79	2.60	2.15	—4.70	12
1.033	68.40	3.30	3.08	3.05	2.89	—3.27	8
1.034	64.83	3.41	2.68	2.81	2.95	—3.54	13
1.035	70.12	4.32	2.70	2.75	2.92	—4.37	10
1.036	66.80	3.95	2.97	3.19	1.28	—4.17	10
1.037	64.16	3.22	4.69	3.73	3.02	—2.26	8
1.038	59.97	3.26	3.39	2.49	3.83	—2.36	9
1.039	66.98	3.93	4.10	2.15	4.28	—1.98	13
1.040	67.18	4.02	4.39	2.44	3.93	—2.07	14
1.041	66.32	3.41	5.21	3.16	4.36	—1.36	11
1.042	64.84	3.14	5.14	2.68	4.82	—.68	12
1.043	66.17	3.76	4.81	3.22	4.41	—2.17	13
1.044	63.54	3.59	5.11	3.08	4.33	—1.56	16
1.045	68.42	3.86	5.54	2.51	5.46	—.83	12
1.046	62.99	3.29	5.31	2.92	5.56	—.90	20
1.047	62.75	2.52	6.33	3.07	6.77	.74	18
1.048	65.97	3.48	6.01	3.33	6.11	—.80	12
1.049	67.01	3.66	6.85	3.42	6.78	—.23	14
1.050	64.07	3.47	6.66	3.03	5.90	.16	16
1.051	61.58	3.17	6.88	3.02	6.35	.61	16
1.052	63.62	3.17	7.19	3.41	6.74	.61	16
1.053	68.33	3.05	7.81	2.89	7.50	1.87	14
1.054	64.40	3.08	8.08	3.19	7.69	1.81	15
1.055	57.71	3.34	7.35	3.52	7.02	.49	16
1.056	61.93	2.79	7.18	3.75	7.78	.64	15
1.057	61.20	3.12	8.45	3.00	7.81	2.33	10
1.058	59.47	2.57	8.44	3.37	7.85	2.50	18
1.059	62.83	3.58	8.54	2.82	8.08	2.14	12
1.060	63.33	3.22	10.16	2.58	9.72	4.36	5
1.061	62.62	3.38	9.30	3.20	9.34	2.72	13
1.062	63.15	2.36	10.76	3.08	9.66	5.32	13
1.063	62.34	2.13	11.44	2.82	10.46	6.49	11
1.064	60.26	2.45	10.49	3.40	9.67	4.64	20
1.065	62.98	2.74	10.82	3.16	10.05	4.92	22
1.066	62.43	2.42	11.38	3.06	10.79	6.90	20
1.067	59.22	1.83	11.51	3.19	11.14	6.49	19
1.068	58.35	1.71	11.75	3.41	11.19	6.63	22
1.069	61.24	1.97	12.10	3.46	11.56	6.67	22
1.070	57.60	2.57	12.24	2.86	11.53	6.81	21
1.071	59.68	1.86	12.53	3.60	11.89	7.07	24
1.072	60.22	1.87	13.06	3.33	12.46	7.86	22
1.073	59.80	2.15	13.09	3.00	12.87	7.94	30
1.074	59.28	1.56	13.45	3.75	13.36	8.14	21
1.075	59.35	2.05	13.58	3.48	13.09	8.05	39
1.076	60.47	1.77	13.96	3.52	13.66	8.67	30
1.077	58.58	1.41	14.58	3.49	13.07	9.68	31
1.078	58.71	1.42	14.53	3.42	14.00	9.69	28
1.079	59.47	1.18	14.86	3.50	14.65	10.18	20
1.080	58.08	1.38	14.92	3.59	14.47	9.95	24
1.081	57.75	1.73	14.79	3.71	14.17	9.35	19
1.082	58.77	1.28	15.88	3.37	15.41	11.23	35
1.083	59.06	1.56	15.96	3.47	15.24	10.93	31
1.074	58.64	1.85	15.93	3.77	15.27	10.31	14
1.085	61.15	.88	16.14	4.39	15.77	10.87	20
1.086	58.03	1.31	16.58	3.41	15.98	11.86	16
1.087	57.55	1.11	17.15	3.89	16.18	12.15	18
1.088	58.41	1.50	17.45	3.96	15.83	11.90	16
1.089	59.56	1.48	17.54	3.85	15.79	12.31	17
1.090	59.01	1.24	17.79	3.06	15.79	13.49	9

SPECIFIC GRAVITY TABLES—Continued.

SORGHUM JUICES, 1881—Continued.

Specific gravity.	Per cent. of juice.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.	Polarization.	Per cent. of available sugar.	No. of analyses.
1.091	53.63	1.50	17.82	4.48	16.45	11.84	12
1.092	53.25	.91	18.48	5.23	....	12.84	3
1.093	56.52	3.62	18.09	2.59	17.00	11.88	3
1.094	55.29	1.03	18.51	3.87	18.62	13.61	2
1.095	59.51	.95	19.58	2.75	....	15.88	1
1.096	....	....	....	....	....	....	....
1.097	....	....	....	....	....	....	....
1.098	54.51	1.37	18.60	3.46	18.70	13.77	2

RELATIVE LENGTHS AND WEIGHTS OF THE DIFFERENT VARIETIES OF SORGHUM.

In the following table will be found the average length of the several varieties of sorghum, as grown upon the experimental plat upon the department grounds, the average weight of the entire plant and of the stalk topped and stripped of its leaves and ready for the mill, as also the number of stalks of each variety upon which such averages are based.

This table will enable any one to determine the relative amount of either variety which may be grown upon an acre, since these several varieties were grown from seed planted the same day and upon a plat of ground which insured practically uniform conditions in every respect, since the culture of all varieties was the same.

A similar table follows for the several kinds of maize which were examined.

For the convenience of those who may wish to estimate the crop of either variety of sorghum or of maize which may be grown to the acre, the following calculations have been made, from which any one may readily determine the weight of his crop according to different methods of planting.

NUMBER OF STALKS PER ACRE.

In drills 3 feet apart and 3 stalks to the foot	43,560
In drills 3½ feet apart and 3 stalks to the foot	36,300
In drills 3½ feet apart and 2 stalks to the foot	24,200
In hills 3½ feet by 3½ feet and 5 stalks to the hill	17,730
In hills 3½ feet by 2 feet and 4 stalks to the hill	24,895
In hills 3 feet by 3 feet and 4 stalks to the hill	19,360
In hills 4 feet by 2 feet and 4 stalks to the hill	21,780

Upon good strong land the drills may be only 3 feet apart, and the stalks may be grown four inches apart, or 43,560 stalks to the acre.

It will be observed that the average loss by stripping and topping is in the case of the sorghums 24.6 per cent. and of the maize 38.4 per cent.

Relative lengths and weights of the different varieties of sorghum.

Table number.	Name.	No. stalks.	Length.	Total weight.	Stripped weight.
			Feet.	*Pounds.*	*Pounds.*
1	Early Amber	111	8.70	1.890	0.960
2	......do	104	8.70	1.410	1.004
3	Early Golden	98	8.70	1.270	1.001
4	Golden Sirup	101	8.50	1.870	1.001
5	White Liberian	62	8.46	1.629	1.337
6	Early Amber	54	8.54	1.817	0.979
7	Black Top Sorghum	48	7.48	1.409	0.961
8	African Sorghum	100	8.59	1.654	1.155
9	White Mammoth	50	9.54	1.637	1.853
10	Oomseeana [Blymyer & Co.]	100	8.26	1.578	1.169
11	Regular Sorgho	101	9.485	1.779	[illegible]
12	Hybrid [E. Link]	43	8.854	1.901	1.379
13	Sugar Cane [J. N. Barger]	51	7.826	1.261	0.893
14	Oomseeana Sorghum [D. W. Aiken]	52	8.396	1.510	1.140
15	Neeazana [W. H. Lytle]	105	7.694	1.512	1.069
16	Goose Neck	94	9.057	1.788	1.255
17	Early Orange	92	8.238	2.115	1.467
18	Neeazana [Blymyer & Co.]	104	7.547	1.450	1.047
19	New Variety [E. Link]	41	9.144	1.562	1.181
20	Chinese	93	7.96	1.722	1.225
21	Wolf Tail	34	8.06	1.449	1.277
22	Gray Top	92	7.419	1.661	1.189
23	Liberian [Blymyer & Co.]	101	8.61	2.870	1.807
24	Liberian [W. H. Lytle]	99	8.29	2.154	1.803
25	Oomseeana [W. I. Mayes & Co.]	83	8.11	2.337	1.728
26	Sumac [Willis Pope]	81	8.70	2.177	1.632
27	Mastodon	46	11.34	2.612	1.928
28	Imphee	41	8.84	2.067	1.543
29	New Variety [J. W. H. Salle]	73	8.83	1.798	1.200
30	Sumac [J. H. Wighton]	86	8.68	2.047	1.528
31	Honduras [Arsenal Grounds]	82	10.09	1.633	1.289
32	Honey Cane	84	11.35	2.771	2.289
33	Spangle Top	90	11.07	2.878	1.854
34	Honduras [E. Link]	62	11.60	2.543	2.143
35	Honey Top or Texas Cane	97	11.48	2.517	2.181
36	Honduras [L. Brande]	81	11.76	2.579	2.079
37	Sugar Cane [C. E. Miller]	120	6.82	1.089	0.731
38	Hybrid [J. C. Moore]	67	8.95	[illegible]	[illegible]
	Sugar Cane [E. Link]	85	9.29	1.700	1.331
	Bear Tail	42	8.06	1.383	1.055
	Iowa Red Top	41	8.39	[illegible]	1.009
	New Variety [F. W. Stump]	41	8.34	1.209	1.037
	West India Sugar Cane	15	7.89	2.107	1.653
	White African	33	7.75	1.434	1.045
	Goose Neck [Gibson]	81	8.19	1.862	1.335
	White Imphee	35	7.60	1.809	0.911
	Hybrid No. 4 [Wallis]	40	8.79	1.410	1.065

Relative lengths and weights of the several varieties of maize.

Name.	Number of stalks.	Length.	Total weight.	Stripped weight.
		Feet.	*Pounds.*	*Pounds.*
Egyptian Sugar Corn	58	8.35	1.710	1.105
Lindsay's Horse Tooth	38	8.93	2.933	1.833
Blount's Prolific	23	9.65	2.065	1.188
Improved Prolific Bread	28	10.03	2.865	1.791
Broad Flat White Dent	19	9.48	2.616	1.664
Long Narrow White Dent	19	9.13	2.874	1.658
Chester County Mammoth	23	8.49	2.782	1.459
18-rowed Yellow Dent	20	8.24	2.860	1.560
Stowell's Evergreen	32	6.08	0.816	0.610
Improved Prolific	26	7.37	1.929	1.483
Sanford Corn	49	5.94	0.862	0.426
Early Minnesota Dent	52	5.78	0.449	0.295

COMPOSITION OF SORGHUM SEED.

Analyses of several varieties of sorghum seed have been made with a view of determining their probable value as food for animals; and, for the purpose of comparison, an average of the analyses of the grain of twenty-one varieties of common field corn is given:

	Early Amber.	Early Amber.	Liberian.	White Mammoth.	Average of the 4.	Average of 21 field corns.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Water	10.50	10.57	9.93	10.90	10.48	9.86
Ash	1.45	1.81	1.47	2.00	1.68	1.54
Fat	4.84	4.60	3.95	4.14	4.26	5.56
Soluble albumen	5.98	7.34	6.90	5.69	6.48	5.93
Insoluble albumen	4.27	2.64	2.64	6.97	4.13	4.97
Sugar	.60	1.91	2.70	.88	1.52	2.20
Gum	.90	1.10	.72	2.20	1.23	2.22
Starch	69.04	68.55	70.17	65.71	68.36	66.80
Crude fiber	2.92	1.48	1.52	1.51	1.86	1.42
	100.00	100.00	100.00	100.00	100.00	100.00

The above analyses show the average composition of the sorghum seed and corn to be of those nutritive constituents which are of value, viz., the albumenoids, fats, and carbo-hydrates or non-nitrogenous matters, as follows:

	Albuminoids.	Fats.	Non-nitrogenous.	Other constituents.
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
Sorghum seed	10.61	4.26	71.11	14.02
Corn	10.90	5.56	71.22	12.32

Upon page 97, Annual Report Department of Agriculture, 1879, after a discussion of the market value of the above nutritive constituents in grains, the following prices are given as being approximately true for our country, viz:

	Cents per pound.
Albumenoids	4.50
Fats	3.84
Non-nitrogenous	.95

At these prices it will be seen that 100 pounds of the sorghum seed would be worth $1.32, and 100 pounds of corn $1.38, or practically almost the same.

The above results appear to have been confirmed by many in their experiments in feeding the sorghum seed; and, as is well known, this grain has been in very extensive use in China for centuries as food for both man and beast.

In the above analyses the percentage of starch as given is determined by difference; but in the analysis, in the attempt to determine the starch by converting it into glucose, there was a considerable portion which resisted such conversion. In the sorghum seed this amounted in the case of the White Mammoth to 17.56 per cent., and in the Early Amber to 19.44 per cent. of the grain.

This substance appears to be incapable of fermentation, is not able to reduce Fehling's solution, and is without action, so far as could be determined, on polarized light. In a sample of corn analyzed there appeared to be only 4.33 per cent. of this substance present. It will be still further examined.

LOSS OF SUGAR IN MANUFACTURE.

The average of two analyses of stripped stalks of sorghum gave 77.85 per cent. of water. Through the inability of the mill to express all the juice fully one-third of the sugar present in the fresh stalks is estimated as left in the begasse. This loss, with our present imperfect methods, is inevitable, and the same is as true of the working of sugar cane as of the sorghums.

In 1879 the experiments made in the manufacture of sirup and sugar showed, as the average of twenty-two separate experiments, that the proportion of sucrose to glucose in the sirup was nearly equal to that existing between these constituents in the juice. For example, in the above twenty-two experiments the average amount of sucrose in the total solids of the sirups was 95.68 per cent. of the amount of sucrose in the total solids of the juice. It will appear then that, provided only the juices are in the proper condition for sugar-making, there is no difficulty in securing a favorable result.

The experiments this year fully confirm the above results. In three experiments, for example, the juices and sirups made from them had the following composition:

Number.	Juices.		Sirups.	
	Sucrose.	Glucose.	Sucrose.	Glucose.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
1	7.26	7.10	30.50	37.00
2	6.95	6.01	36.39	34.40
3	14.29	1.79	59.85	6.50

The percentage of sucrose in the sum of the two sugars in the juices and sirups is as follows:

Number.	Juices.	Sirups.	Sucrose obtained in sirup.
	Per cent.	*Per cent.*	*Per cent.*
1	50.6	45.2	89.3
2	53.6	51.4	95.9
3	88.9	90.2	101.5

The above calculation, it will be seen, shows only that there has been in the process of making the sirup little diminution in the relative amounts of sucrose as compared to the glucose, but there is no indication of the absolute amount of sucrose recovered of that present in the juice, since the presence of the same relative proportion of sucrose to glucose in juice and sirup may be due either to no change having taken place in either, or to the fact that a proportionate change has taken place in both, so that the loss of sucrose by inversion may be just counterbalanced by a corresponding destruction of glucose. Careful estimates have been made this year to determine the absolute loss of sucrose incurred in the manufacture, and the results show that in the forty experiments made the amount of sucrose recovered in the sirup was 87.5 per cent. of the actual amount in the juice, while individual cases show that the entire quantity was recovered. But it must be remembered that, owing to the slight and unavoidable errors of analysis, it is obvious that the multiplication of that error in estimating the total sugar in a large amount of juice or sirup renders any single result in itself unreliable; but, since the errors are as likely to be upon one side as another, the average results of so large a number of separate experiments may be regarded as close approximations to the truth.

ANALYSIS OF JUICE AT DIFFERENT STAGES.

It has been supposed by some that the increase in the amount of sugar at certain periods is due to the drying up of the plant and the consequent concentration of the juice by evaporation.

This view, although apparently supported by some facts, is probably erroneous, since, as will appear from the results of our determinations, as shown upon either of the charts showing the average results for a year, the amount of juice varies but little during the year; but owing to continuous increase in the sucrose, glucose, and other solids during the season, as shown by the analyses and indicated by the steady increase in specific gravity, it follows of necessity that the amount of water in the juice must as steadily decline.

This, however, would hardly appear as the result of a drying up of the plant, since, as has been shown, neither the amount of juice nor its composition suffers any great change, even when a heavy rainfall succeeds a period of prolonged drought.

It appears rather a normal condition of the plant's growth, and the production of sugar seems to be accompanied by the elimination of a certain amount of water.

If at any time we might look for more concentration of juice by the evaporation of water, and the consequent increase in the percentage of the several constituents of the juice, it would seem to be during the later periods of the plant's growth. If, now, we take the results for the past season as given in the general averages, we find that, for example, the amount of total solids obtained in the juice were in the fifteenth, sixteenth, and seventeenth stages, 12.35, 12.56, and 12.30 per cent. of the weight of the stripped stalks, but the amount of water in the juices at these periods was, for these respective stages, 51.19, 47.69, and 46.65 per cent. of the weight of the stripped stalks.

As will be seen, there is in the above results a slow diminution of water, but no corresponding increase of the solids.

The following table gives the results for the past season, showing the per cent. of juice and of each of its constituents, as also of available sugar calculated to the stripped stalks:

Percentage of sucrose, total solids, water, and available sugar in stripped stalks, obtained in juice at different stages.

Stages.	Per cent. of juice obtained.	Specific gravity.	Per cent. of total solids.	Per cent. of water.	Per cent. of sucrose.	Per cent. of available sugar.	Pounds of available sugar in one ton of stripped stalks.	Number of analyses.
1	65.30	1.018	3.66	61.64	.58			16
2	67.13	1.025	4.60	62.53	.81			38
3	69.48	1.029	5.28	64.20	1.28			40
4	68.02	[illegible]	5.67	62.35	1.37			52
5	68.18	1.032	6.39	61.79	1.90			46
6	68.07	1.035	6.85	61.22	2.45			51
7	67.21	1.042	7.66	59.55	3.17			42
8	67.81	1.048	8.68	59.13	4.12			42
9	66.76	1.052	9.21	57.55	4.99	76	15.20	45

Percentage of sucrose, total solids, water and available sugar, &c.—Continued.

Stages.	Per cent. of juice obtained.	Specific gravity.	Per cent. of total solids.	Per cent. of water.	Per cent. of sucrose.	Per cent. of available sugar.	Pounds of available sugar in one ton of stripped stalks.	Number of analyses.
10	67.91	1.056	9.96	57.95	5.95	1.94	38.80	60
11	65.84	1.061	10.44	55.40	6.58	2.73	54.60	53
12	62.44	1.068	11.04	51.40	7.50	3.96	79.20	44
13	62.50	1.071	11.57	50.90	8.16	4.76	95.20	40
14	58.92	1.075	11.25	47.67	8.24	5.23	104.60	37
15	63.54	1.077	12.35	51.19	9.11	5.87	117.40	37
16	60.25	1.083	12.56	47.69	9.63	6.71	134.20	40
17	58.95	1.081	12.30	46.65	9.40	6.50	130.00	37
18	56.51	1.081	12.12	44.39	9.39	6.65	133.00	45
19	57.22	1.080	11.80	45.42	8.71	5.62	112.40	43
20	58.45	1.069	10.20	48.25	6.95	3.97	79.40	370

It will be seen in the foregoing table that there is an uninterrupted increase in the percentage of sucrose, total solids, available sugar, and specific gravity, with a corresponding decrease in the percentages of water, to about the sixteenth stage. It will be seen that during the sixteenth, seventeenth, and eighteenth stages the per cent. of available sugar in the stalks remains nearly constant and at its maximum, although the per cent. of sucrose and of available sugar in the juice obtained, as has been shown, is at its maximum at the eighteenth stage.

The number of pounds of available sugar to be obtained from a ton of stalks at the different stages is also given in a separate column. From these results it would appear, as the average result of 122 analyses of thirty-five varieties of sorghum, that 133 pounds of sugar from a ton of stripped stalks is not beyond the limits of even probability. It will also be seen that these same stalks, if cut while the seed was in a doughy condition, as shown by the ninth stage, would yield only 15 pounds of sugar per ton of stalks.

THE INCREASE IN SUGAR DURING THE LATER STAGES IN THE DEVELOPMENT OF THE SORGHUM IS BUT THE RESULT OF A LOSS OF WATER OR DRYING UP OF THE PLANT.

This is a matter of such great practical importance to the manufacturer of sugar from the sorghums, that a fuller discussion of the facts obtained by analysis is justified, since, if it were true that the absolute amount of sugar present in the plant was at its maximum during the early stages in its development, it would certainly be advisable that the crop be worked at such time as showed the greatest per cent. of juice, since obviously a larger per cent. of the sugar actually present in the plant would be extracted by pressing the cane at such time as showed the maximum per cent. of juice.

It is true, as will be seen, that the per cent. of juice expressed by the mill is greatest in the earlier stages of development, and it is also true that the actual amount of water present in the plant, and in the expressed juice, is less at the later stages in the plant's life.

But it is obvious that if the increased per cent. of sugar, as shown in the juice at these later stages, was due simply to loss of water through a drying up of the plant, then it would necessarily follow that by such evaporation the relative percentages of the several constituents present in the juice would be maintained; but such is far from being the case, as will be seen by the following table, for while the sugar and the solids not sugar increase, it will be seen that their increase is by no means proportional, the sucrose increasing from the first to the seventeenth stage 688 per cent., while the solids increase only 135 per cent.; besides, glucose, instead of increasing, as would be natural and inevitable if we regard the matter as simply one of loss of water by evaporation, decreases 65 per cent.

But it is obvious that if the water present in the juice at the different stages be multiplied by the per cent. of the several constituents, as, *e. g.*, sucrose, the series of products would necessarily be a constant quantity; but, on the other hand, we find that the sucrose increases 606 per cent., the solids 111 per cent., while the glucose *decreases* 68 per cent. Such a result is wholly at variance with the view that the increase of sugar is only apparent and due to the evaporation of water.

It will be observed that the actual increase in sugar in the plant is in reality greater than is shown in the above results, since it is obvious that a larger proportion of that present in the plant is expressed at the time when the amount of water is at its maximum, viz., during the earlier stages, and that a larger proportion is left in the begasse during the later stages.

Table showing that the increase in sugar during the later stages is not due to a drying up of the plant.

Stages.	Per cent. of solids.	Per cent. of juice.	Per cent. of water.	Number of analyses.	Per cent. of sucrose.	Per cent. of glucose.	Per cent. of solids.	Water × sucrose.	Water × glucose.	Water × solids.
1	7.73	58.72	54.18	59	1.74	4.26	1.73	.943	2.307	.937
2	9.23	59.52	54.03	70	2.93	4.44	1.86	1.583	2.399	1.005
3	9.71	59.58	53.79	58	3.47	4.45	1.79	1.867	2.394	.963
4	10.49	61.58	55.12	72	4.29	4.28	1.92	2.365	2.359	1.058
5	11.14	63.00	55.98	77	5.06	4.11	1.97	2.834	2.302	1.103
6	12.79	62.60	54.59	64	6.40	3.94	2.45	3.494	2.151	1.337
7	13.43	63.84	55.27	70	7.38	3.86	2.19	4.079	2.133	1.210
8	13.89	65.65	56.53	111	7.69	3.83	2.37	4.347	2.165	1.340
9	14.56	64.96	55.50	266	8.95	3.19	2.42	4.967	1.770	1.343
10	15.08	64.94	55.15	217	9.98	2.60	2.50	5.507	1.434	1.379
11	15.73	65.04	54.81	166	10.66	2.35	2.72	5.970	1.105	1.511
12	16.08	63.62	53.39	170	11.18	2.07	2.83	5.912	1.095	1.497
13	16.25	63.14	52.88	183	11.40	2.03	2.82	5.868	1.045	1.451
14	16.60	61.72	51.47	191	11.76	1.88	2.96	6.053	.968	1.524
15	16.65	60.45	50.39	217	11.69	1.81	3.15	5.891	.912	1.587
16	17.36	61.20	50.58	339	12.40	1.64	3.32	6.272	.830	1.679
17	19.35	60.17	48.53	197	13.72	1.56	4.07	6.658	.757	1.975
18	17.19	62.09	51.42	191	11.92	1.85	3.42	6.129	.951	1.759

AVAILABLE SUGAR IN JUICE OF MAIZE.

The average per cent. of available sugar in the juices of eight varieties of common field maize grown upon the department grounds, and from which the crop of ripe corn was obtained, was 4.45 per cent., and the per cent. of available sugar in the sirup made from these juices was 16.74.

The average number of bushels of shelled corn gathered from the above eight varieties was at the rate of 48.4 bushels per acre. The entire plat was about one-sixth of an acre. Owing to the severe drought the stalks had dried up before the time of working to a great extent, and the average weight of stripped stalks per acre it was impossible to determine, but those which were the least dried up yielded of stripped stalks at the rate of 16.432 pounds per acre.

This would not give the results which have been obtained in the experiments of previous years, but indicates as a result in available sugar 366 pounds per acre, in addition to the 48.4 bushels of shelled corn.

In contrast to these results some maize stalks grown by Dr. Dean gave the following results in available sugar:

No. 1. Juice, — .05 per cent.; sirup, — 9.68 per cent.

No. 2. Juice, —1.01 per cent.; sirup, —10.96 per cent.

These stalks had lain several days, after being cut, before they were worked, and it is quite probable that the results are due to this cause.

Several examinations were made of the juice of sugar-corn stalks from which the ears had been removed for canning. The average of seven different analyses of separate lots gave, in available sugar, 6.38 per cent. of the juice. From the above results, which have been also obtained in previous years, it would appear to be very probable that sugar could be profitably obtained from this practically refuse material. At least, good sugar has been repeatedly obtained from corn stalks in our previous experiments, and in quantity and quality fully warranting the continuance of efforts looking to its extraction upon a large scale.

Two years in succession sugar has been produced from stalks upon which the corn had ripened, at the rate of fully 900 pounds per acre.

THE WORK OF THE LARGE SUGAR MILL.

Mention has already been made of the several plats of sorghum of different varieties upon the lands of Mr. Patterson, Mr. Golden, and Dr. Dean, which were intended for working upon a scale of sufficient magnitude to afford a practical demonstration of the economical production of sugar upon a commercial scale.

Owing to the backward spring and the ravages of wire and cut worms, two successive plantings of seed almost entirely failed, and it was only after thoroughly coating the seed with coal tar that a final stand of cane was secured. This third planting was concluded June 18, fully seven weeks after the planting of the plat upon the department grounds, the examination and working of which has already been discussed in the preceding pages. To any one who has carefully perused this report thus far, or either of the reports of the preceding years, giving the results of our examination of sorghum, it is entirely useless to say that this delay was fatal to success in the production of sugar, and that failure was inevitable, unless all our previous experience was to be falsified.

The failure of the crop to mature, as had been confidently predicted during the summer, was fully realized, and at last, with the assurance that the frosts would soon render the crop unfit even for sirup, owing to its immature state, it was resolved to begin work, since, with the limited capacity of the mill, it would require at least two months to work up the entire crop of 135 acres. Accordingly the work of cutting the cane began September 19, and grinding began September 26, and was continued without any serious interruption until October 28. At this time the cane still remaining upon the field, through the effect of frosts and succeeding warm weather, had become worthless, and the cane from only 93½ acres in all was brought to the mill, the last portions of which had already become sour and offensive.

Those portions worked were of the earliest varieties planted, since there was more hope of possible success with those than with the other varieties which matured still later.

As in the experiments with the small mill, each load of cane was weighed, the juice measured in the defecator, of which the capacity was known, and at intervals during the day samples of the freshly-expressed juices were taken for analysis in the laboratory. The sirups produced were also carefully weighed and also analyzed.

As evidence of the condition of the crop, it may be mentioned that all the seed which had sufficiently matured to make it possible to save, was carefully gathered, and the total product of the 93½ acres was about 150 bushels, or one and two-thirds bushels per acre. If, now, we estimate only 17 bushels of seed to the acre as a reasonable crop for land of the character of that selected for growing this sorghum, it will be seen that only 10 per cent of the crop had reached maturity, and unfortunately, as this was so intermixed with the other nine-tenths in every condition of immaturity, a large portion of which was not even in blossom, the resulting sirups produced may be anticipated.

Since this matter, although already discussed, is of such vital practical importance in connection with the production of sugar from sorghum, a brief review at this time of some of the salient points clearly established will be appropriate.

RESULTS FROM ANALYSES OF THIRTY-FIVE VARIETIES OF SORGHUM IN 1881, WORKED AT LARGE MILL.

AVAILABLE SUGAR.

By reference to the table giving the general results from analyses of thirty-five varieties of sorghum in 1881, it will be seen that the available sugar in their juices during the successive stages was as follows:

Stage.	Per cent.
1. Not headed out	— 3.82
2.	— 4.45
3. Fully headed out	— 3.92
4.	— 4.29
5. In full blossom	— 3.81
6.	— 2.87
7. Seed in milk	— 1.98
8.	— .64
9. Seed in dough	+ 1.14
10.	+ 2.86
11. Seed hard	+ 4.14
12.	+ 6.34
13.	+ 7.61
14.	+ 8.87
15.	+ 9.24
16.	+11.14
17.	+11.02
18.	+11.77
19.	+ 9.83
20.	+ 6.79

Now, as has been already stated, a large portion of the crop was not yet in blossom, *i. e.*, was at about the fourth stage, while not over a tenth had matured the seed, *i. e.*, reached the eleventh stage. If we take an average of the fifth to the eleventh stages, inclusive, we shall find that while the ninth, tenth, and eleventh stages give a total of 8.14 per cent. plus, the fifth, sixth, seventh, and eighth stages give a total of 17.51 per cent. minus available sugar, or an average for the seven stages of —1.17 per cent. It will be remembered that by this is meant that the per cent. of sucrose was 1.17 less than the sum of the per cents of glucose and solids in the juices. It will follow, then, that the average condition of the crop was such as to absolutely forbid the hope of any sugar being produced, and that its production, at any period during the working, was only possible when a lot of cane might happen to be brought in which was considerably better than the average, as indeed happened two or three times during the month of grinding.

The following tables represent the results of the work, and it will be seen that these results are in entire harmony with the preceding statements:

TABLE A.—*Canes crushed.*

Received from—	Tons.	Pounds.
W. L. Palmer	104	80
S. M. Golden	99	1,304
Dr. Dean	25	1,060
Total	228	2,444

TABLE B.—*Juices evaporated at sugar mill, Department of Agriculture.*

Date.	Designation.	Specific gravity.	Gallons after defecation.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of other solids.	Per cent. of sucrose by polariscope.	Per cent. + available sucrose.	Per cent. — available sucrose.	Juice.	Glucose.	Sucrose.	Solids.	Sucrose by polariscope.	Available sucrose.	Available sucrose.
1881.										*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*+Lbs.*	*—Lbs.*
Sept. 27	Morning, No. 1265	1.057	1,663.2	3.86	9.39	1.74	8.62	3.79	....	14,080.7	543.51	1,322.18	245.00	1,213.76	533.67	....
23	Afternoon, No. 1284	1.066	1,771.2	9.66	6.30	2.99	4.71	None.	6.35	14,984.4	1,447.49	1,254.02	548.03	705.66	....	741.50
28	Morning, No. 1267	1.063	....	9.99	4.46	2.24	2.01	None.	7.77	....	....	....	....	....	....	....
29	Morning, No. 1287	1.061	1,479.6	5.24	9.69	.85	8.78	3.60	....	12,517.4	655.91	1,212.94	106.39	1,099.08	....	106.39
29	Afternoon, No. 1290	1.063	....	9.00	5.52	2.05	4.08	None.	5.53	....	....	....	....	....	....	....
30	Morning, No. 1294	1.065	1,738.8	12.20	3.45	2.66	3.25	None.	11.41	14,700.2	1,793.42	507.16	391.03	477.76	....	1,677.29
30	Afternoon, No. 1310	1.059	....	5.84	8.70	2.22	8.91	0.64	....	....	....	....	....	....	....	....
Oct. 1	Morning, No. 1316	1.069	1,123.2	10.43	5.88	2.39	5.40	None.	6.94	9,502.8	991.09	558.74	227.10	513.12	....	659.45
3	Morning, No. 1334	1.075	831.6	11.74	5.63	2.90	2.69	None.	9.01	7,035.8	825.94	396.09	204.02	189.25	....	633.87
3	Afternoon, No. 1339	1.068	....	3.62	11.56	3.17	12.21	4.77	....	....	....	....	....	....	....	....
4	Morning, No. 1343	1.070	1,155.6	5.85	9.79	1.08	10.58	2.86	....	9,776.4	571.92	957.11	105.59	1,029.45	279.60	....
4	Afternoon, No. 1357	1.063	....	2.78	11.75	1.08	11.54	7.89	....	....	....	....	....	....	....	....
4	Afternoon, No. 1358	1.063	....	3.50	11.08	1.31	11.14	6.27	....	....	....	....	....	....	....	....
5	Morning, No. 1373	1.074	550.8	3.84	13.44	.55	12.55	9.05	....	4,659.8	178.94	626.28	25.63	584.80	421.71	....
6	Morning, No. 1386	1.070	723.6	5.72	9.98	1.82	10.01	2.44	....	6,121.7	350.16	610.96	111.42	612.78	149.87	....
6	Morning, No. 1393	1.055	....	7.39	5.04	1.83	3.64	None.	4.18	....	....	....	....	....	....	....
6	Morning, No. 1375	1.066	....	5.80	9.02	1.83	8.13	1.89	....	....	....	....	....	....	....	....
10	Morning, No. 1445	1.043	1,522.8	5.23	5.28	.99	3.58	None.	.94	12,[illegible].9	673.77	680.21	127.54	454.76	....	121.10
10	Afternoon, No. 1456	1.068	....	8.19	6.67	1.85	5.76	None.	3.37	....	....	....	....	....	....	....
11	Morning, No. 1466	1.060	1,944.0	3.89	9.85	1.59	8.25	4.37	....	16,446.2	630.75	1,619.95	261.49	1,356.81	718.71	....
11	Morning, No. 1473	1.051	....	4.04	7.81	1.47	6.49	2.90	....	....	....	....	....	....	....	....

12	Morning, No. 1476	1.053	1,938.2	4.68	7.15	1.46	6.54	1.01		16,354.9	765.40	1,169.37	238.78	1,076.15	165.19	
12	Afternoon, No. 1490	1.044		4.19	6.82	.38	5.23	2.25								
13	Morning, No. 1499	1.057	1,976.4	4.37	8.31	1.46	7.85	2.48		16,721.7	730.78	1,369.57	241.18	1,312.65	417.71	
13	Afternoon, No. 1501	1.052		4.51	7.45	1.30	6.28	1.64								
14	Morning, No. 1503	1.055	756.0	4.86	7.87	Lost.	6.28			6,395.8	810.19	503.34	121.52*	401.65	71.63	
14	Morning, No. 1504	1.060		4.49	8.78	Lost.	7.83									
15	Morning, No. 1519	1.058	1,512.0	1.35	10.75	3.49	7.85	5.91		12,791.5	182.68	1,375.68	446.42	1,004.13	745.98	
15	Morning, No. 1520	1.071		3.93	10.68	4.15	10.06	2.60								
15	Afternoon, No. 1521	1.067		4.74	11.19	2.43	9.85	4.02								
17	Morning, No. 1532	1.074	723.6	7.14	8.91	2.94	7.84	None.	1.17	6,121.7	437.09	545.44	179.98	479.94		71.63
17	Morning, No. 1533	1.069		11.63	3.40	3.11	0.78	None.	11.34							
19	Morning, No. 1550	1.029	1,846.8	5.79	1.08	1.09	—	None.	5.80	15,633.9	905.20	168.85	170.41			906.76
19	Morning, No. 1551	1.031		6.24	0.55	1.64	—	None.	7.33							
19	Afternoon, No. 1543	1.029		6.09	0.71	1.36	—	None.	6.74							
20	Morning, No. 1556	1.084	993.6	14.35	4.11	1.69	1.16	None.	11.93	8,405.9	1,206.25	345.48	142.06	97.51		1,002.83
20	Morning, No. 1558	1.045		8.19	2.40	1.13	1.82	None.	6.92							
20	Afternoon, No. 1559	1.055		8.17	4.16	1.59	3.69	None.	5.60							
20	Afternoon, No. 1560	1.024		5.00	0.64	2.12	—	None.	6.48							
22	Morning, No. 1575	1.032	1,544.4	7.12	5.03	1.60	4.08	None.	3.69	13,065.6	930.27	657.20	209.05	533.08		482.12
22	Afternoon, No. 1577	1.055		6.65	6.05	2.41	5.91	None.	3.01							
26	Morning, No. 1605	1.057	1,004.4	6.79	5.32	3.02	6.13	None.	4.49	8,497.2	576.96	452.05	256.52	520.88		881.43
	Average	1.0583	1,339.74	6.383	6.943	1.899	6.614	3.643	6.190							
	Total		26,794.8	268.08	291.60	75.98	251.36	69.28	130.00	226,295.5	14,716.67	16,242.01	4,359.11	12,563.17	3,503.57	6,835.87

* The solids were estimated at the average from the other juices. Per cent. of sucrose by polariscope of that by analysis, 78.16.

TABLE C.—*Sirups made at sugar-mill, Department of Agriculture.*

Date.	Designation.	Specific gravity.	Gallons, 231 cubic inches.	Weight.	Per ct. of glucose.	Per ct. of sucrose.	Per ct. of other solids.	Per ct. of sucrose by polariscope.	Per ct. of available sucrose.*	Glucose.	Sucrose.	Solids.	Sucrose by polariscope.	Available sugar.	Available sugar.
1881.				*Pounds.*						*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	+*Lbs.*	—*Lbs.*
Sept. 27	Car 17, No. 1281	1.453	7.50	90.89	23.50	50.92	8.98	29.24	18.44	21.36	46.28	8.16	26.58	16.76	....
27	Car —, No. 1282	1.429	120.00	1,430.14	31.60	41.04	11.36	38.23	— 1.92	451.92	586.93	162.46	547.00	....	27.45
29	Car 7, No. 1289	1.430	123.75	1,475.87	32.75	37.34	14.71	31.27	—10.12	483.35	551.00	217.00	462.00	....	149.35
30	Car 20, No. 1309	1.392	120.00	1,393.11	42.25	30.69	18.05	30.62	—29.61	588.59	428.00	251.00	427.00	....	411.59
30	Car 21, No. 1315	1.426	127.50	1,516.34	41.50	32.78	12.32	29.40	—21.04	629.28	497.00	187.00	446.00	....	319.28
Oct. 1	Car 22, No. 1320	1.492	116.25	1,446.53	38.10	38.38	10.52	28.76	—10.24	551.13	555.18	152.17	416.00	....	148.12
1	Car 23, No. 1321	1.420	112.50	1,332.32	40.00	31.07	14.93	26.65	—23.86	532.93	414.00	199.00	355.00	....	317.93
3	Car 24, No. 1338	1.426	123.75	1,471.74	38.50	33.25	15.25	30.21	—20.50	566.62	489.00	224.00	445.00	....	301.62
3	Car 25, No. 1338	1.426	18.75	222.99	38.50	33.25	15.25	30.21	—20.50	85.85	74.14	34.01	67.37	....	45.72
4	Car 25, No. 1354	1.420	101.25	1,199.08	37.50	32.78	7.52	30.38	—12.24	449.66	393.06	90.17	364.28	....	146.77
5	Car 8, No. 1377	1.4[illegible]	135.00	1,590.90	17.65	53.35	9.00	53.02	25.10	280.79	848.75	152.73	853.04	415.23	....
6	Car 19, No. 1392	1.405	71.25	834.89	15.50	52.63	9.67	54.76	27.46	129.41	439.40	80.73	449.19	229.26	....
8	Car 8, No. 1444	1.404	90.00	1,053.84	23.65	44.56	8.59	41.31	12.32	249.23	469.59	90.52	435.34	129.84	....
11	Car 2, No. 1472	1.414	146.25	1,724.69	27.00	47.60	6.00	37.91	14.60	465.67	820.95	103.48	653.83	251.80	....
11	Car 5, No. 1475	1.430	120.00	1,431.14	29.25	42.75	8.08	38.81	5.50	418.61	611.81	114.49	555.43	78.71	....
12	Car 26, No. 1498	1.427	105.00	1,249.62	27.90	41.42	9.48	38.56	4.04	348.64	517.59	118.46	481.85	50.49	....
13	Car 27, No. 1502	1.423	112.50	1,335.18	28.00	41.80	13.20	38.56	.60	373.84	558.08	176.24	514.83	8.00	....
14	Cars 9 and 10, No. 1506	1.398	138.75	1,615.23	25.65	41.23	12.92	37.83	2.66	414.31	665.96	208.69	611.04	42.96	....
14	Car 10, No. 1507	1.397	90.00	1,048.59	25.00	41.04	14.96	37.34	1.08	262.15	430.34	156.87	391.54	11.32	....
17	Car 13, No. 1534	1.382	93.75	1,055.53	21.80	43.61	10.19	40.33	11.62	230.11	460.23	107.56	425.70	122.56	....
17	Car 28, No. 1534	1.382	127.50	1,469.55	21.80	43.61	10.19	40.33	11.62	320.36	640.87	149.75	592.67	170.76	....
18	Car 3, No. 1541	1.391	93.75	1,087.60	36.65	26.98	13.37	23.24	—23.04	398.61	293.43	145.41	252.76	....	250.59
19	Car 4, No. 1553	1.388	116.25	1,345.70	18.00	47.03	7.97	47.95	21.06	242.23	632.88	107.25	645.26	283.40	....
19	Car 11, No. 1553	1.388	56.25	651.15	18.00	47.03	7.97	47.95	21.06	117.21	306.24	52.10	322.82	136.93	....
20	Car 19, No. 1555	1.395	123.75	1,439.74	51.50	14.73	9.17	21.87	—45.94	741.47	212.07	132.02	314.82	....	661.42
21	Car 14, No. 1561	1.385	3.75	43.32	39.35	26.32	14.53	22.84	—27.56	17.05	11.40	6.29	9.89	....	11.94
21	Car 28, No. 1561	1.385	146.25	1,689.32	30.35	26.32	14.53	22.84	—27.56	664.75	444.63	245.46	385.84	....	465.58
24	Car 17, No. 1579	1.389	131.25	1,520.43	33.25	36.39	9.36	32.40	— 6.22	505.54	553.28	142.30	492.62	....	94.56
28	Car 1, No. 1633	1.309	105.00	1,225.10	36.15	36.39	....	32.08	....	442.87	445.81	....	393.01	2.94	....
	Average	1.411	....	....	31.02	38.49	11.38	35.02	— 3.68	....	....	....	....	....	....
	Total	....	2,977.50	34,990.48	....	....	....	....	....	10,983.54	13,397.90	3,815.15	12,337.22	1,957.96	3,351.92

* Obtained by subtracting the sum of "glucose" and "other solids" in juice from the percentage of sucrose.

Average weight per gallon .... pounds.. 11.75
Average specific gravity 1.409
Average gallons juice for one gallon sirup 9.00
Average per cent. sirup from juice 11.08
Average specific gravity of juice 1.058
Average available juice from stalks .... per cent.. 51.60
Average pounds stripped stalks for one gallon sirup 154.0

Per cent. of total sucrose in juices recovered in sirups 82.49
Per cent. of total glucose in juices recovered in sirups 74.64
Per cent. of total solids in juices recovered in sirups 87.53
Per cent. of total sugars in juices recovered in sirups 78.75
Per cent. of sucrose by polariscope of that by analysis 92.07

WORK OF LARGE MILL CONTINUED.

It will be seen by the preceding tables that, of the juices analyzed, nineteen gave an average per cent. of available sugar of 3.643 plus, while twenty-one gave an average per cent. of 6.190 minus, or a total average of the forty equal to 1.518 minus.

Also, of the sirups analyzed, fourteen gave an average per cent. of available sugar of 12.65 plus, while fourteen gave an average per cent. of 20.03 minus, or a total average of the twenty-eight equal to 3.68 minus.

It will be observed also that, of the several lots of juice worked, nine gave an aggregate of 3,504 pounds of available sugar, while eleven lots gave an aggregate minus amount of 6,835 pounds; or, in other words, had these juices been all mixed in one lot, and had there been added 3,331 pounds of sugar to the lot, it would have been practically impossible to have recovered a pound of that added or of that present originally in the juice.

The table of sirups shows that, of the twenty-nine analyzed, fifteen gave an aggregate of 1,958 pounds of available sugar, while the remaining fourteen gave an aggregate of 3,152 pounds minus of available sugar; or, in other words, had these twenty-nine sirups been thrown together in one lot, and had 1,194 pounds of pure sugar been added to the lot, it would have been impossible to have recovered from this mixture a pound of the sugar added or originally present in the sirup.

It will also be observed that during the process of manufacture there was lost 17.5 per cent. of the sucrose in the juice, 25.4 per cent. of the glucose, and 12.5 per cent. of the solids.

It is noticeable that the loss of glucose was considerably greater than that of sucrose, and this may be due to the action of lime, which effected the destruction of glucose, as has been long known to be the case. It is probable that this decrease in the relative amount of glucose accounts for the fact that the average determinations with the polariscope are more nearly those of analysis in the sirups than in the juices, they being only 8 per cent. less than the analysis in the case of the sirups, while they are nearly 22 per cent. less than the results of analysis in the case of the juices.

The character of the canes worked may also be seen by the low specific gravity averaging 1.058 and the low percentage of sirup which the juice yielded upon evaporation 11, for, as will be seen by reference to the work of the small mill, the average of twelve lots of juice from canes grown upon the department ground gives 21 per cent. of sirup of a greater density also, in the juice, or nearly double the amount of that obtained above, while, as will be seen, the above specific gravity is that of juice from canes which have not yet attained their best condition, since, as the analytical results show, the maximum content of both sirup and sugar was found when the average specific gravity of the juices was 1.082.

THE CAUSES OF FAILURE IN SUGAR-MAKING FROM SORGHUM.

The preceding results of the investigations which have been made will serve to satisfactorily account for our own failure and the failures of others in their efforts at sugar-making from sorghum.

Briefly stated, the several chief sources of failure are as follows:

1. The immaturity of the sorghum at the period when it is cut and worked. This may be due to late planting, as in our experience the past season, or to the selection of a variety which requires more time for its complete maturity than the season in any given latitude may give. The importance, then, of selecting only such varieties as will

mature sufficiently long before frosts, so as to give a reasonable time to work up the crop, cannot be overestimated.

The time required for the several varieties to reach a good condition for working for sugar from the time of planting the seed has been found to be, from the results of our experiments in 1880 and 1881, as follows:

Time from planting to maturity and number of days for working.

Varieties.	1881.				1880.				Average.		
	Number of analyses.	Days from planting to working period.	Days for working.	Average available sugar.	Number of analyses.	Days from planting to working period.	Days for working.	Average available sugar.	Days from planting to working period.	Days for working.	Available sugar.
Early Amber	24	96	106	10.12	80	77	99	7.89	87	102	9.00
Early Golden	26	92	110	10.02	76	80	104	6.62	86	107	8.32
White Liberian	25	92	110	10.41	39	88	101	8.95	90	106	9.68
Do	25	92	110	10.61	......	......	......	......	92	110	10.61
Black Top	15	108	76	11.08	35	87	87	8.41	98	82	11.08
African	20	117	85	9.82	83	87	107	6.90	102	96	8.36
White Mammoth	9	122	42	10.60	32	102	83	8.88	112	63	9.74
Oomseeana	15	109	75	10.76	54	115	77	7.60	112	76	9.18
Regular Sorgho	7	118	18	9.78	71	101	93	7.28	110	56	8.53
Link's Hybrid	21	96	106	11.02	80	101	84	9.88	98	95	9.95
Do	23	105	97	11.36	......	......	......	......	105	97	11.36
Sugar Cane	23	99	103	10.86	28	108	77	9.20	104	90	10.03
Goose Neck	6	122	16	11.34	44	111	72	7.81	117	44	9.58
Bear Tail	10	109	56	9.76	......	......	......	......	109	56	9.76
Iowa Red Top	13	104	70	12.64	......	......	......	......	104	70	12.64
New Variety	19	92	92	11.63	......	......	......	......	92	92	11.63
Early Orange	14	112	72	10.73	53	117	79	8.21	115	76	9.47
Do	19	116	86	9.91	......	......	......	......	116	86	9.91
Orange Cane	14	113	71	9.56	......	......	......	......	113	71	9.56
Neeazana	20	113	89	6.78	38	136	58	8.39	125	74	7.59
Wolf Tail	24	108	94	9.67	21	118	56	7.51	113	75	8.59
Gray Top	21	112	90	6.79	83	135	59	8.02	124	75	7.41
Liberian	7	126	38	8.55	22	131	38	7.91	129	38	8.23
Mastodon	9	123	41	8.66	23	128	60	6.53	126	51	7.60
Honduras	7	126	25	6.56	27	148	29	4.97	137	27	5.77
Sugar Cane	11	112	62	7.82	......	......	......	......	112	62	7.82
Hybrid, Wallis	4	119	8	9.45	......	......	......	......	119	8	9.45
White Imphee	8	108	56	11.90	......	......	......	......	106	56	11.90
Goose Neck	18	112	72	9.29	......	......	......	......	112	72	9.29
White African	20	103	97	8.21	......	......	......	......	103	97	8.21
West India Sugar Cane	8	107	49	10.70	......	......	......	......	107	49	10.70
Sugar Cane	4	131	23	8.76	......	......	......	......	131	23	8.76
New Variety	10	101	51	8.30	......	......	......	......	101	51	8.30
Early Amber	10	101	53	10.78	......	......	......	......	101	53	10.78
Honey Cane	2	139	15	7.68	21	133	43	5.73	136	24	6.71
Average	......	110	39	9.77	......	111	74	7.72	110	69	9.30

CAUSES OF FAILURE IN SUGAR-MAKING FROM SORGHUM CONTINUED.

By reference to the experiments made with the small mill, and to the explanation made of the failure in making sugar in the large mill, it will be seen that there was a difference of nearly 100 per cent. between the per cent. of available sugar in the juices of the suckered and unsuckered plats of sorghum operated upon, and that this difference was obviously due to the presence, along with the ripe cane, of a certain proportion of cane from suckers in different stages of immaturity, the juices from which, as we have seen, contained a minus amount of available sugar, and therefore diminished the yield otherwise attainable from the mature canes. So also with the crop for the large mill, the successive plantings of seed produced a lot of cane of almost every degree of development, except that of complete ripeness; since not over 10 per cent. had matured its seed; and the analyses of the juices and sirups showed a result which was anticipated. It is therefore of importance, for the purpose of sugar production, that the crop of cane be not only ripe, but that it should be carefully suckered, or, if they (the suckers) be allowed to grow, that in cutting the canes for the mill these suckers should be carefully kept apart, and removed to be worked up for sirup, for which only they are suitable. It is possible that some varieties of sorghum may be found in which this tendency to throw up suckers from the roots is not so strong as in others, and, other things being equal, such varieties are much to be preferred for sugar production.

It should be the aim, then, to secure a good stand of sorghum at the first planting, since the replanting of such portions of the field as should fail at the first would destroy the equality of the crop, and unless time should allow of this second planting to mature, it would be far better to leave such portions of the field bare, unless such canes were reserved solely for sirup.

2. Another frequent cause of failure is due to allowing the sorghum to remain some time after being cut up before it is worked at the mill. That such a course may be pursued in certain seasons and in certain localities without producing an unfavorable result has been established beyond much doubt; but the climatic conditions which render such a procedure possible are imperfectly understood at the present, and repeated experiments have demonstrated that after being cut up the juices are subject to chemical changes which speedily result in the destruction of the crystallizable sugar. For the present, then, the only safe course to pursue is to work up the cane within at most 24 hours after it is cut up.

3. A third cause of failure exists in an imperfect method of defecation of the juice. The object of defecation, and the method by which it is accomplished, should be carefully studied and as thoroughly understood by the sugar-boiler as is possible, for, although somewhat complex in its details, the general principles which underlie this important step are few and easily comprehended.

The juices of sorghum or of maize, like the juice of sugar cane or of beets, contain, besides sugar, several other substances, the removal of which it is the object of defecation to accomplish, and the more completely the removal of these other substances is effected the greater the percentage of the sugar present in the juice which may be obtained.

Among these impurities of the juice are certain organic acids and organic salts, nitrogenous matters, and salts of mineral acids, together with glucose and the mechanical impurities, as fragments of cane.

The universal practice among sugar-makers from sugar cane is to add to the juice an amount of lime, generally as milk of lime, sufficient to neutralize the free acid found in the juice, and then to heat the juice to boiling.

The effect of the lime is not only to neutralize the free organic acids, but to form with certain other of these impurities insoluble lime salts.

The effect of the heat is to coagulate certain of the nitrogenous substances present in the juice.

Upon allowing the juice which has been brought to the boiling point to stand a few moments there will be found a heavy scum upon the surface consisting largely of the coagulated matters which have mechanically entangled and brought to the surface the fragments of cane and other mechanical impurities of the juice. At the bottom of the defecator will be found a sediment, more or less abundant, composed largely of the lime salts formed, and which, generally being heavier than the juice, will soon settle to the bottom.

If, however, the juice is very dense, it will occasionally happen that this sediment will remain suspended in the juice, neither rising to the surface nor settling to the bottom. In such event it will be found necessary to draw the juice, after skimming, into a cooling tank, or allow it to remain in the defecator until these impurities shall settle; or it may be hastened by adding to the juice, after skimming, enough cold water to dilute the juice, and thus diminish its density, so that the lime salts present may settle. By reference to the result of our experiments already given, it will be seen that this method may be pursued without loss of sugar.

After the subsidence of these impurities the juice may be drawn off from above this sediment, and it will be found to be, if the operation has been properly conducted, quite clear and almost colorless. It is then to be evaporated to a sirup as speedily as possible, and such additional impurities as rise to the surface, especially during the earlier stage in the evaporation, are removed by skimming.

From the above the importance of removing all those impurities which have been rendered insoluble by the action of the lime and heat combined is manifest, since if allowed to remain it will be found that they are but imperfectly removed during evaporation, and consequently remain to a great extent in the sirup, causing it to be muddy in appearance, impure in its composition, and disagreeable in quality.

CHARACTER AND COMPOSITION OF SORGHUM JUICE — CHEMICAL CHANGES IN SUGAR-MAKING.

In order that the sugar-boiler may understand the nature of this operation and the character of the problem to be solved in defecation, as also to assist those who may desire to experiment for themselves in an effort to improve the present method, the following statement as to the character and chemical composition of the juice of sorghum is given, as also an account of certain of the chemical changes to which it is subject under certain conditions which naturally would exist in the ordinary operations of sugar-making.

SORGHUM JUICE.

The juice expressed from the sorghum at or near maturity is a liquid containing quite a large amount of suspended matter, giving it a color varying from green to a deep brown. This suspended matter is deposited to a greater or less extent on standing, and consists of very fine starch granules, colored violet-blue by iodine, and easily discolored by the acids of the juice, fiber, and albumen, with the green coloring matter of the outer portions of the stalk, and sometimes a red coloring matter from the center of the stalk.

After allowing it to settle a few minutes, it has a specific gravity of from 1.06 to 1.09, and contains in solution, in addition, the substances in suspension, most prominently sucrose, with smaller amounts of glucose, aconitic acid, soluble albumen, amide bodies, and inorganic salts. It can be freed from albumen, organic and some inorganic acids, by means of basic acetate of lead, and this method of defecation is in use in most laboratories in the analytical determination of the content of sugar in the cane. The filtrate, after the addition of the acetate of lead, contains in addition to the sugars nothing which reduces Fehling's copper solution with the exception possibly of a very small amount of amide substances.

The following examination of a juice collected on November 2, 1881, though somewhat late in the season and after a slight frost, will illustrate some points in the general composition:

White Liberian cane juice, No. 1678.

Per cent. of juice		65.00
Specific gravity		1.062
Total solids	per cent.	15.67
Glucose	do	2.17
Sucrose by titration	do	9.79
Sucrose by polarization	do	9.15
Solids not sugar	do	3.51
Containing—		
Albumen	per cent.	.13
Amido bodies, including ammonia salts	do	.37
Nitrate of potash	do	.01
Inorganic ash	do	1.12
Organic acids and fiber	do	1.90

The inorganic part of the juice consists of soluble silica, iron, lime, magnesia, potash, phosphates, sulphates, chlorides, nitrates.

All attempts to detect gum or any carbo-hydrates other than glucose and sucrose in the juice, before it has changed its character by standing, have failed.

After the juice has been left to itself, with or without the addition of ferments, it undergoes certain changes.

In the first place, it deposits a white substance which, under the microscope, shows the organized structure of starch. The granules are, however, much smaller than most starches, and do not give as deep a blue color with iodine, the color fading out in a short time. On longer standing there collects a greenish precipitate on the surface of the starch, containing fiber, albumen, and coloring matter. The supernatant liquor, however, never becomes entirely clear.

During the course of from twenty-four to forty-eight hours in warm weather fermentation sets in, even with no addition of yeast. The products are not strictly those of the vinous fermentation, neither are they entirely like the lactic. Much lactic acid is, however, formed, together with a large amount of mannite and a smaller amount of alcohol, acetic acid, glycerine, and succinic acid. The same thing takes place even when quite large quantities of yeast have been added to the juice.

If the juice immediately on extraction is filtered through paper and allowed to stand, the cellulosic fermentation sets in, and over night white clots of cellulose, or a similar substance, settle out on the walls of the containing vessel. What the products in solution are, under these circumstances, has not been investigated. If the expressed juice is immediately mixed with numerous slices of fresh cane and left to itself, lactic fermentation is probably the form to be expected. The same form of fermentation always occurs on adding slices of cane to a pure sugar solution. If, however, to the juice sufficient slices of cane are added to fill the vessel as nearly as possible with them, then the mucous fermentation takes place. After a few days the liquid becomes sticky, and alcohol precipitates from it a ropy slime, not easily soluble in water, and resembling the gum found in many sorghum sirups.

THE ACIDITY OF CORN AND SORGHUM JUICES.

The juices of four varieties of sorghum and two of corn have been examined at various intervals during the growth of the canes to determine their acidity, and with the result presented in the following tables.

While it is impossible to draw any very definite general conclusions, owing to the great irregularity in the amount of acid present in juices expressed from canes in the same stage of development, it is apparent that in all but one of the varieties which have been examined there is a greater amount of free acid in the juice during the later stages of growth. Two of the sorghums show besides an apparent decrease to about the eighth or ninth stage, followed by an increase later on in the development of the canes. Beyond these conclusions it is impossible to go.

The determinations were made in the following manner:

The method employed for the volumetric determination of the acid present in sorghum or maize-stalk juice was as follows:

50 c. c. of the juice, usually of a greenish or greenish-brown color, was titrated with a fiftieth normal solution of sodium hydrate $\left(\frac{n}{50}NaOH\right)$.

The acid was calculated as malic acid $=(H_2C_4H_4O_5)$.

1 c. c. of $\frac{n}{50}$HNaO=, .00134 malic acid.

As the most practical indicator for the final test of saturation of the acid juice by soda solution, a dilute solution of extract of logwood was used, which, when added to the juice containing a slight excess of NaOH, turned to a bluish-purple or violet color. This final reaction was made in small porcelain dishes, into which a few drops of juice were brought and some drops of logwood added by means of a glass rod. Before this point of neutrality was reached, red and blue litmus paper was employed.

The calculation was as follows:

Of No. 622 sorghum juice, 50 c. c. required—

1. 44 c. c. of $\frac{n}{50}$HNaO solution for saturation; hence 100 c. c. of juice $44\times2=88.0$.
2. 88, $\times$.00134 (malic acid)=, .11792.
3. $\frac{.11792 \text{ (malic acid)}}{1.0660 \text{ (specific gravity of juice)}}$=, .11051 gram of malic acid in 100 c. c. of juice.

SORGHUM JUICE ACIDITY.

EARLY AMBER, ROW 1.

Date.	Stage.	Number of analysis.	c. c. of $\frac{N}{50}$ HNaO for 100 c.c. of juice.	Specific gravity of juice.	Per cent of acid as malic.
July 23	7	332	96	1.041	.123
July 25	9	359	100	1.047	.12[illegible]
July 25	9	351	120	1.049	.153
July 28	9	411	124	1.053	.158
July 29	10	441	96	1.058	.1[illegible]
Aug. 1	11	501	120	1.066	.151
Aug. 8	12	578	156	1.072	.19[illegible]
Aug. 24	15	819	196	1.083	.24[illegible]
Aug. 26	15	850	192	1.080	.23[illegible]
Aug. 27	15	888	156	1.081	.192
Aug. 31	16	942	136	1.081	.167
Sept. 3	17	1,004	160	1.081	.196
Sept. 7	17	1,059	192	1.080	.[illegible]
Sept. 10	18	1,118	196	1.081	.243
Sept. 17	18	1,220	236	1.086	.2[illegible]

SORGHUM JUICE, ACIDITY—Continued.

GOLDEN SIRUP, ROW 4.

Date.	Stage.	Number of analysis.	c. c. of $\frac{N}{50}$ HNaO for 100 c.c. of juice.	Specific gravity of juice.	Per cent. of acid as malic.
July 27	10	391	182	1.039	.170
Aug. 1	11	504	156	1.073	.195
Aug. 8	12	581	160	1.075	.200
Aug. 19	14	763	184	1.083	.228
Aug. 24	15	822	152	1.085	.188
Aug. 26	15	854	196	1.086	.239
Aug. 29	16	893	172	1.079	.213
Aug. 31	16	945	192	1.089	.236
Sept. 3	17	1,007	164	1.091	.201
Sept. 7	17	1,062	180	1.095	.220
Sept. 17	18	1,223	252	1.087	.311

SORGHUM JUICE, ACIDITY.

WOLF TAIL, ROW 21.

Date.	Stage.	Number of analysis.	c. c. of $\frac{N}{50}$ HNaO for 100 c.c. of juice.	Specific gravity of juice.	Per cent. of acid as malic.
July 21	3	404	128	1.048	.164
July 28	4	425	120	1.042	.154
July 29	5	453	132	1.049	.156
July 30	6	474	84	1.053	.107
Aug. 1	5	516	92	1.054	.117
Aug. 10	8	622	88	1.066	.111
Aug. 16	9	696	120	1.077	.149
Aug. 20	9	783	88	1.065	.111
Aug. 25	10	846	108	1.078	.134
Aug. 30	11	913	156	1.086	.155
Sept. 1	12	964	120	1.087	.148
Sept. 5	13	1,029	152	1.084	.189
Sept. 9	14	1,087	148	1.094	.181
Sept. 14	15	1,175	152	1.090	.187
Sept. 27	....	1,254	156	1.086	.192

SORGHUM JUICE, ACIDITY.

OOMSEEANA, ROW 25.

Date.	Stage.	Number of analysis.	c. c. of $\frac{N}{50}$ HNaO for 100 c.c. of juice.	Specific gravity of juice.	Per cent. of acid as malic.
July 28	1	428	132	1.032	.171
Aug. 2	1	522	64	1.033	.083
Aug. 11	2	632	92	1.045	.118
Aug. 11	3	633	80	1.044	.103
Aug. 11	4	634	92	1.043	.118
Aug. 16	5	701	72	1.055	.091
Aug. 16	6	702	62	1.056	.079
Aug. 21	7	788	80	1.062	.101
Aug. 26	8	866	80	1.061	.101
Aug. 30	9	917	100	1.072	.125
Sept. 2	10	976	96	1.075	.119
Sept. 5	11	1,038	100	1.078	.125
Sept. 9	12	1,091	68	1.065	.084
Sept. 15	13	1,184	152	1.076	.190
Sept. 27	....	1,258	160	1.072	.200

CORN JUICE, ACIDITY.

EGYPTIAN SUGAR CORN, PLAT 1.

Date.	Stage.	Number of analysis.	c. c. of $\frac{N}{50}$ HNaO for 100 c.c. of juice.	Specific gravity of juice.	Per cent. of acid as malic.
July 25	9	366	93	1.034	.121
July 26	10	372	152	1.030	.197
Aug. 1	11	481	122	1.050	.156
Aug. 6	11	575	152	1.036	.197
Aug. 8	12	585	140	1.034	.181
Aug 9	11	597	124	1.043	.159
Aug. 17	13	729	164	1.038	.211
Aug. 18	14	760	184	1.083	.228
Aug. 23	14	805	92	1.058	.117
Aug. 27	15	880	148	1.062	.186
Aug. 31	16	934	136	1.040	.175
Sept. 2	17	990	80	1.061	.109
Sept. 7	17	1,051	1,04	1.073	.129
Sept. 10	......	1,104	1,32	1.042	.169
Sept. 10	18	1,110	1,48	1.047	.198

LINDSAY'S HORSE TOOTH CORN, PLAT 2.

Date.	Stage.	Number of analysis.	c. c. of $\frac{N}{50}$ HNaO for 100 c.c. of juice.	Specific gravity of juice.	Per cent. of acid as malic.
July 25	9	367	152	1.033	.197
July 26	9	373	128	1.030	.166
Aug. 1	11	482	156	1.040	.201
Aug. 1	10	484	132	1.050	.168
Aug. 6	11	576	118	1.041	.151
Aug. 8	12	587	112	1.040	.144
Aug. 23	14	806	112	1.042	.144
Aug. 27	15	881	140	1.041	.180
Aug. 31	16	935	116	1.050	.146
Sept. 2	17	991	56	1.056	.071
Sept. 7	17	1,052	64	1.032	.083
Sept. 10	18	1,111	124	1.061	.157

IMPORTANCE OF A GOOD MILL.

It is most desirable, in order to secure the best results possible, that great care be exercised in the selection of a mill, since, as is well known, there is, even with the best mill, a very considerable amount of sugar left in the bagasse. According to the testimony of an experienced sugar chemist and engineer, it is probably true that nearly if not one-half of the sugar present in the cane of Louisiana is left in the bagasse, for he says:

To a great many it may appear startling that about 50 per cent. of the sugar is left in the cane after it passes through the ordinary mill. Some who doubt this base their opinions on the apparent dryness of ordinary bagasse, while others arrive at their conclusions from experiments which, from their nature, are fallacious. The fallacy lies in the high percentage of juice claimed for the mills. It is probably quite correct that by taking a few hundred, or even a few thousand, pounds of cane, and passing them carefully through a good mill, such high percentages may be secured; but with the average mill, grinding in the ordinary way, I have reason to believe that the percentage of juice obtained, on the whole weight of the cane, is more frequently under fifty than over.

The above estimate of loss is undoubtedly too high, but all are agreed that there is a very great loss in this operation of expressing the juice.

To illustrate this more fully, let us take the average results of the analyses made in 1881 of the sorghums during those three periods when the best results in sugar were found.

The average composition of the juices at this time was as follows, and it must be remembered that these canes were passed singly through a mill, giving, as will be seen, excellent results in juice:

	Per cent.
Juice expressed	58.57
Sucrose in juice	16.18
Glucose in juice	1.83
Solids in juice	3.07

But 21.08 per cent. of the juice, the amount of total solids, is 12.35, which, subtracted from the percentage of juice, leaves 46.22 per cent. as the amount of water expressed in the juice.

Now, the amount of water actually present in the cane at this period is probably not less than 75 per cent., which would leave in the bagasse 28.78 per cent. of the weight of the cane as water, and since the bagasse constitutes 41.43 per cent. of the weight of the cane, there would still remain in the bagasse 69.47 per cent. of its weight of water. This to the ordinary observer would appear incredible, since the bagasse is so generally spoken of as being perfectly dry as it passes from the mill.

It is obvious therefore that, since even a good mill leaves 38.37 per cent. of the water of the cane in the bagasse, there also remains along with this water a large amount of sugar, and that this amount, if not equal to that estimated above, is yet sufficiently great to demand that only such mills should be used as will secure the greatest percentage of juice.

If in the above calculation the amount of sugar lost is in proportion to the per cent. of water remaining in the bagasse, it is clear that 46.22: 28.78::9.477:5.901; *i. e.*, while in the expressed juice there is an amount of sugar equal to 9.48 per cent. of the weight of the cane, there is an amount of sugar equal to 5.90 per cent. of the weight of the cane left in the bagasse, equal to 62.27 per cent. of the amount actually expressed in the juice, and equal to 38.40 per cent. of the total amount present in the cane, which, as will be seen, is equal to 15.38 per cent. of the weight of the stripped stalk.

From this it would appear that the general estimate as to the proportion of sugar actually recovered in a marketable condition is not far from the truth, the several sources of loss being given as follows:

	Per cent.
Left in bagasse	6
Lost in skimming	2.5
Lost in molasses	3
Raw sugar obtained	6.5
Total in cane	18.

LOSS OF SUGAR IN THE BAGASSE.

In a previous report some results were given, which, through an oversight in the calculation, were erroneous, and these results are again repeated, in order to correct the error. Two varieties of sorghum and one of maize stalks were selected for the experiment. Carefully selected stripped stalks of each kind were taken, and, in order to obtain an average, each stalk was split lengthwise into halves. The half of each kind was carefully weighed, dried, and analyzed; the other half of each variety was passed through the mill, and the bagasse weighed, dried, and also analyzed. From the results given below, it will be seen that in each case the per cent. of water present in the cane was less than the per cent. remaining in the bagasse; the average per cent. of water in the three varieties of cane analyzed being 80.2 per cent., while the average per cent. of water in the three bagasses is 85.5 per cent. This rather surprising result is of course due to the fact that the expressed juice, which averaged 48.24 per cent. of the weight of the stripped stalks, contained a larger percentage of solid matter than did the fresh cane.

It will be observed also in these results that the amount of sugar expressed in the juice was greater in proportion than would be due to the amount of water expressed, for while not more than half the water was expressed, it appears that an average of four-fifths of the sugar in the cane was expressed with the water. From the published results of numerous other experiments, it would appear that the proportional amount of sugar which is expressed with the ordinary mill pressure is not a constant quantity, but depends upon the amount present, since the following results show a wide variation in this respect; for, while the per cent. of water in the Honduras and Sugar Corn were nearly the same, as also the per cent. of juice expressed, the total sugar found in the Honduras was nearly twice the amount found in the Sugar Corn, and while only 15.2 per cent. was lost in the bagasse from the Sugar Corn, there was 23.8 per cent. lost in the bagasse from the Honduras. These experiments are of so great practical importance that this matter should be more thoroughly investigated.

Loss of sugar in the bagasse.

	Honduras.	Honduras.	Early Amber.	Early Amber.	Sugar Corn.	Sugar Corn.
Weight of stripped cane .... pounds..	1,428	1,390	651	905	882	875
Weight of juice .... pounds..		666		447		415
Weight of bagasse .... pounds..		724		458		460
Per cent. of juice		47.91		49.39		47.43
Per cent. of bagasse		52.09		50.61		52.57
Per cent. of water in cane	80.0		75.7		84.9	
Per cent. of water in bagasse		84.0		83.7		88.7
Per cent. of dry matter in cane	20.0		24.3		15.1	
Per cent. of dry matter in bagasse		16.0		16.3		11.3
Per cent. of sugars in dry bagasse		21.8		19.4		10.1
Per cent. of sugars in dry cane	38.1		34.7		26.0	
Per cent. of sugars in fresh cane	7.63		8.44		3.93	
Per cent. of sugars in fresh bagasse		3.48		3.16		1.14
Per cent. of sugars in bagasse to that in cane		45.7		37.4		29.0
Per cent. of sugars lost in bagasse		23.8		18.9		15.2

ACTION OF LIME UPON THE GLUCOSE AND SUCROSE IN JUICES DURING EVAPORATION.

In the three sets of experiments, the results of which are given below, a solution of the strength given equal in volume to 2,000 c. c. was placed in a large glass flask and boiled in the open air over a gas stove for several hours.

Samples were taken at first, and at varying intervals during the process of boiling, and subjected to analysis. These samples were always taken just after the evaporated water had been replaced. The amount evaporated was determined by graduations upon the side of the flask, but on account of the width of the column of liquid it was difficult always to bring the solution back to the exact volume of the original, and, doubtless, some of the irregularities recorded below are due to this cause.

In each sample taken for analysis the acidity or alkalinity, glucose and sucrose were determined, the sugars being estimated by the same methods used in the analysis of juices.

In the series of Experiments No. 1, no color appeared until sample No. 5 was taken, at the end of four and a half hours' boiling; the solution then became gradually darker until sample No. 8 was taken, which was very much darker than sample No. 7.

No. 9 was still much darker, and then the coloration proceeded gradually until the end, sample No. 11 being of a sherry-wine color.

In the series of Experiments No. 2, there was a gradual darkening of color till the end, sample No. 24 in this series resembling a dark whisky in color.

In the series No. 3, sample No. 1 was colorless; No. 2 was dark-brown with a heavy precipitate. The color gradually darkened to the end. Sample No. 12 was a very dark-red wine color.

EFFECT OF LIME DURING EVAPORATION OF JUICES.

EXPERIMENT No. 1.—*No lime added to solution.*

Number of sample.	Time of boiling.	$Ca(HO)_2$ in 1,000 c.c.	$Ca(HO)_2$ required to neutralize 1,000 c.c.	Glucose in 100 c.c.	Sucrose in 100 c.c.	Gain in glucose.	Loss in sucrose.
	Hours.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Per cent.*	*Per cent.*
1	0	....	.004	2.24	14.81	....	....
2	2	....	.005	2.88	14.22	29	1
3	2½	....	.002	3.19	13.69	42	4
4	3	....	.002	3.55	13.00	58	9
5	4½	....	.004	4.73	12.13	111	15
6	7½	....	.002	8.83	8.35	294	42
7	10½	....	.009	12.13	5.53	442	61
8	13½	....	.020	15.67	1.57	600	89
9	16½	....	.022	17.20	1.52	668	89
10	18	....	.029	18.70	.81	735	94
11	22	....	.032	20.30	.00	806	100

EXPERIMENT No. 2.—*A little lime added to solution.*

Number of sample.	Time of boiling.	$Ca(HO)_2$ in 1,000 c.c.	$Ca(HO)_2$ required to neutralize 1,000 c.c.	Glucose in 100 c.c.	Sucrose in 100 c.c.	Gain in glucose.	Loss in sucrose.
1	0	.067	....	2.34	20.29	....	....
2	½	.041	....	2.38	19.61	2	3
3	1	.023	....	2.43	19.57	4	4
4	1½	.031	....	2.57	19.58	10	3
5	2	.031	....	2.66	18.16	14	11
6	2½	.023	....	2.86	18.37	22	9
7	4	.014	....	3.44	17.88	47	12
8	5½	.011	....	3.90	17.22	67	15
9	5½	.014	....	3.95	16.68	69	18
10	7	.007	....	5.08	14.94	117	26
11	8½	.005	....	6.40	14.26	174	30
12	10½	....	.005	7.95	12.20	240	40
13	11½	....	.013	10.28	10.45	339	49
14	13	....	.020	12.50	8.66	434	57
15	15	....	.025	14.90	7.75	537	62
16	15½	....	.029	15.68	5.18	570	74
17	16	....	.034	16.73	4.44	615	78
18	17½	....	.036	17.28	2.38	638	88
19	20½	....	.050	18.83	1.82	705	91
20	23½	....	.072	20.73	0.38	786	98
21	26½	....	.063	20.30	0.40	768	98
22	29½	....	.104	20.60	−0.80	780	101
23	31	....	.115	21.80	−0.78	832	104
24	35	....	.115	21.65	−0.05	825	100

EFFECT OF LIME DURING EVAPORATION OF JUICES—Continued.

EXPERIMENT No. 3.—*Much lime added to solution.*

Number of sample.	Time of boiling.	Ca (H O)₂ in 1,000 c. c.	Ca (H O)₂ required to neutralize 1,000 c. c.	Glucose in 100 c. c.	Sucrose in 100 c. c.	Gain in glucose.	Loss in sucrose.
	Hours.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Per cent.*	*Per cent.*
1	0	0.000	....	2.31	14.76	....	....
2	0	4.003	....	.28	6.60	87.9	55.3
3	½	3.110	....	.10	6.56	95.7	55.6
4	1½	....	....	.07	6.66	97.0	54.9
5	3	2.563	....	.05	6.68	97.8	54.7
6	4½	2.577	....	.01	7.43	99.6	49.7
7	7½	2.563	....	.02	7.17	99.1	51.4
8	10½	2.520	....	.04	6.93	98.3	53.1
9	13½	2.549	....	.04	6.68	98.3	53.1
10	16½	1.541	....	.02	6.94	99.1	53.0
11	18	1.321	....	.02	6.77	99.1	54.0
12	22	1.226	....	.07	7.18	97.0	51.4

In considering the results of the above experiments, it will be observed that in the series of the first experiment, where no lime was added, there was a continuous increase in the amount of glucose and a decrease in the amount of sucrose as the result of the boiling, but it will be observed that after an interval of two hours the actual loss in sucrose was only .09 gram, while the increase in the glucose was .64 gram; but, as is well known, the .09 gram sucrose would furnish by its inversion only .0947 + gram of glucose, which is much less than the gain shown. It is probable that the commercial glucose was composed of other compounds largely intermediate between starch and glucose—compounds which would have no effect upon Fehling's solution, but which by boiling were readily converted into glucose, or some copper-reducing compound.

The general result, however, is manifest, viz., the rapid and continuous inversion of the sucrose present, until at the close of the experiment sample 11 showed no sucrose present, and an increase of over 800 per cent. in the amount of glucose.

The increase in the acidity of the solution is noticeable, amounting to 800 per cent. and determined by the amount of lime required to neutralize the solution, 1,000 c. c. requiring at the beginning only .004 gram, but at the end of the experiment .032 gram. It will be observed that this increase was by no means constant, but was most marked after about eleven hours' boiling.

In the series of Experiments No. 2, where a small amount of lime was added to the solution, it will be observed that the solution, at first alkaline, becomes, after about nine hours' boiling, slightly acid, and this acidity increases steadily to the end of the experiment, until at the end of thirty-five hours' boiling the amount of lime necessary to restore neutrality was twice as much as that originally added to the solution. It will also be observed that after the solution had become distinctly acid the inversion of the sugar became much more rapid.

It will be seen, also, that during the earlier periods of this experiment the amount of glucose increases but slightly, although there is a gradual decrease of sucrose. This is doubtless due to the fact that the action of the lime is mainly exerted in the destruction of glucose, as has been shown in previous reports to be true in our experiments in sugar-making from sorghum and maize juices.

The practical point, however, to be observed is, that so long as the solution remained distinctly alkaline there was but very slight loss in sugar and slight increase in glucose, two desirable conditions in the economical production of sugar from sorghum. And it is also to be remarked that, so soon as this alkalinity was destroyed through the formation of acid products during the boiling, the inversion of sugar became rapid, and the accumulation of glucose becomes very marked. These results are obviously most undesirable in sugar-making. The conclusion thus far would be that the solution should be, during boiling, kept slightly alkaline.

In the series of Experiments No. 3, where a larger quantity of lime was added to the solution, the effect at the outset was to remove from the solution as a precipitate about half of the sugar, and the remainder during eighteen hours of boiling was found to be unchanged in amount; on the other hand, the action of this excess of lime upon the glucose was very marked, effecting practically its destruction within two hours, and producing from the glucose other compounds of high color, which dissolved in the liquid and gave it a deep wine-red color.

It would appear from this last series of experiments that an excess of lime has no action upon cane sugar, as has already been established, and that its effect is to diminish rapidly the glucose present, and darken the solution.

The above experiments corroborate the results of our practical working with large quantities of juice, and explain fully the loss of glucose shown to be present in the fresh juices, but which was found in comparatively small quantity in the sirups manufactured from these juices

APPENDIX.

In the following appendix there will be found the reports of the engineer, Mr. Harvey; of the sugar-boiler, Mr. Lynch; and of Mr. Parsons, my assistant, to whom was intrusted the collection of data during the work with the large sugar-mill.

The information embodied in all of them will fully corroborate all which has been already said as to the reasons for failure, as also give good reason to anticipate success in the future.

There is also appended a bibliography of sorghum, arranged chronologically, and a general index for the several reports upon sorghum and maize, to be found in the Annual Reports of this Department for 1878, 1879, 1880, and the present volume.

Dr. PETER COLLIER, *Chemist:*

SIR: I have the honor to submit the following brief statement, embodying in condensed form a report of my observations in connection with the manufacture of sirup and sugar from sorghum while engineer in charge of the machinery used for this purpose at the Department of Agriculture.

Work was commenced on the 26th of April with one of Colwell's three-roll horizontal mills, having a general capacity on ordinary hard stalks of two and a half tons per hour.

The mill worked well; the bagasse was good and dry; the open evaporators and the vacuum-pan every way satisfactory. Used Blake's vacuum-pump, which, after a new set of springs had been added, also worked satisfactorily. The engine was connected with the centrifugal with an eight-horse power, and worked unusually well. All the machinery, in fact, was in number one order, giving no trouble whatever during the entire season. Did not have to stop one hour from the time work commenced till the work closed on account of the machinery.

The quality of the stalks delivered to the department was, in my opinion, poor, evidently not being ripe enough. A great deal of rust was noticed in the cane, owing probably to the drought.

The general management of the juices was in charge of Mr. Lynch, a practical sugar-maker from Baltimore, while the defecation was in charge of Mr. Duvall, an experienced defecator.

The sirup, before the sugar was separated, was very light and of excellent quality, and measured nearly 3,000 gallons. One hundred and sixty-five pounds of nearly white sugar was obtained from the sirups made this year. A small amount of a second crystallization of the sirup, purged from this sugar, was also noticed.

The gumminess, which gave so much trouble last year, occasioned partly by the way the vacuum-pan was handled and partly in the centrifugal, caused no trouble this year, showing that with proper treatment and proper handling of the vacuum-pan, and a proper centrifugal, this gum, so-called, will not be any serious inconvenience to the sugar.

The sirups made this year were all very fair with one exception, no disagreeable sorghum taste, so-called, being generally noticeable. No difficulty was found in selling this sirup to wholesale dealers at 33 cents per gallon.

Number of pounds of cane crushed	458,444
Number of gallons of juice obtained	26,794
Number of pounds of sirup obtained	34,965
Number of gallons of sirup obtained	2,977
Number of pounds of sugar obtained	165

It was necessary to employ seventeen men in working this sugar-mill, laborers being paid $1.50 per diem, skimmers $1.75 per diem, and mill-feeders $2.25 per diem. One and one-half tons of soft Cumberland coal, 2,240 pounds to the ton, were used on an average run from 6 o'clock a. m. till 10 p. m., costing $5.50 per ton delivered at the department.

Amount paid for labor and running mill	$1,342 11
Amount paid for coal and wood	325 48
Total	1,667 59

Very respectfully,

JOHN S. HARVEY, *Chief Engineer.*

SYNOPTICAL STATEMENT OF MR. PETER LYNCH.

Mr. Peter Lynch, who had the general management of the sorghum business, superintending its manufacture into juice, sirup, and sugar, says that he has had fifteen years' experience as a sugar-boiler with Cuban molasses, cane sugar, grape sugar, &c. That of the 206½ gallons of light sirup obtained October 5 and 6, 1881, there were from 175 to 200 pounds of sugar obtained—nearly one pound per gallon. It was good sugar, worth 8 to 9 cents a pound wholesale. Would polarize between 96 and 98. No special means were used to obtain this result. It was boiled to a proof that would granulate. The juice from which this was made contained on an average from 2.8 to 3½ per cent. of glucose and from 11 to 13¼ per cent. of cane sugar.

The mill worked excellently, and every particle of juice possible was extracted. Had this same quality prevailed with all the season's juice, the same average quality of sugar would probably have been obtained every day.

The only canes really worth anything were those worked that day. On other days the proportion of glucose was greater, owing to bad cane. Do not think the quality of sirup made this year as fair an average as might be expected with fair soil, fair climate, &c. Good soil ought to raise from 16 to 18 tons of stripped stalk.

For the results of the season's work no blame can be attached to the machinery or anything else. The only cause for failure to make sugar was that the cane was not sufficiently ripe.

STATEMENT OF THE FARMER, L. J. CULVER.

On Tuesday, May 10, I began planting the sorghum, using "Link's Hybrid" and "Early Amber" seed. I planted about thirty acres of each variety, but very little of it sprouted, owing to the cold, damp weather that immediately followed the sowing. On the 27th I commenced replanting the same varieties, and this lot of seed was nearly all destroyed by worms. On June 7 I commenced replanting the *third* time, and finished the work June 18. This third lot of seed was rolled in coal-tar in order to drive away the worms. It sprouted quickly, but on July 15 the cane did not average one foot in height. I began cutting the cane September 19.

WASHINGTON, D. C., *November* 2, 1881.

Prof. PETER COLLIER,
Chemist, Department of Agriculture:

SIR: Herewith I present a report of the work done at the sugar-mill between September 27 and October 28, 1881.

Machinery.—The machinery was in charge of Mr. John Harvey, engineer of this department. His report is appended, and states that everything about the machinery was satisfactory, the only drawback being an occasional lack of water in the condenser connected with the vacuum-pan; this lack of water prevented as rapid evaporation from the vacuum-pan as might otherwise have been attained, but the sirups made seem not to have been injured by the longer boiling and the slightly higher temperature of the vacuum-pan.

Management of juices.—The practical treatment of the sorghum juices was in charge of Mr. Peter Lynch, of Baltimore, Md. Mr. Lynch is a sugar-boiler of fifteen years' practical experience in the working of Cuban molasses for sugar; he has also had two years' experience in working sorghum juices at Crystal Lake, Illinois. Mr. Lynch's management was such, in my opinion, as to afford the best results obtainable from the juices furnished. A synopsis of his report is appended.

Analyses and calculations.—The undersigned has kept a careful account of the amounts of cane and juices worked, and of the products obtained in form of molasses and sugar; during one week's absence this part of the work was in charge of Mr. C. Wellington of this division. The analyses here represented were made by laboratory assistants who have had such an amount of experience during the past two years as to entitle the results obtained to the fullest confidence.

Methods of analysis.—The methods used in these analyses were those detailed in Annual Report of this Department, 1880, p. 42.

Polariscope tests.—Each juice and each sirup was polarized in order to have a check on the analyses made by the other method. It appears that when a juice or a sirup is "normal," that is, when it contains a much smaller amount of uncrystallizable sugar (glucose) than of crystallizable sugar (sucrose), the results are fairly comparable with those obtained by analysis, being usually a little lower; but when juices or sirups are "abnormal," that is, contain more glucose than sucrose, the results obtained by the polariscope are no longer trustworthy.

Quality of juices.—Except on the afternoon of October 4 and the morning of October 5, the amounts of glucose and solids not sugar in the juices were either in excess of the amounts of sucrose, or so nearly equal thereto, as to afford no reasonable ground for the belief that any considerable crystallization could be expected. It is generally conceded by practical sugar-makers that when the amount of substances not crystallizable sugar are equal to or exceed the amount of crystallizable sugar in any sirup, little or no crystallization can take place; certainly not enough to pay for separating the crystals. And, further, it is known to be a fact that the greater the excess of crystallizable sugar above the glucose and other solids in the sirup, the greater will be the amount of crystals which can be recovered from the sirup.

Quality of sirups.—The sirups obtained were such as would be expected from the composition of the juices worked. Those made on October 5 and 6, from the juices extracted October 4 and 5, were a very light color, pleasant taste, and have already furnished 200 pounds of very high-grade raw sugar; they are now again crystallizing and will furnish a considerable additional amount of crystals.

It is probable that the sirups made on October 19 may furnish some crystallizable sugar, as may also several other samples made on the 8th, 11th, and 17th of October. The latter can hardly furnish enough to pay for the expense of separation from the molasses.

The sirups from which no crystallization may be expected were in nearly every case of medium color, good body, and were remarkably free from the raw, unpleasant taste so frequently noticed in sorghum sirups which have not been properly made. Mr. Lynch, who is a practical judge, affirms that they are worth on an average fully ten cents more per gallon than Cuban molasses, and that they are well adapted for use, without refining, for domestic and bakers' cooking. An offer of 33 cents per gallon for the whole lot has already been made.

Tables A, B, and C, presented on page 506, need no explanation. They represent, it is believed, all the more important practical results attained, so far as such results can be expressed in figures.

In conclusion, I would state that this season's experience in the sugar-mill has developed the following facts:

1st. The canes used were, with one exception, too immature.

2d. The juices were, consequently, not of such composition as to give any promise that the sirup made from them could furnish any considerable amount of crystals. (See this report, Table B, page 506.)

3d. The sirups were, consequently, of such composition as could not be expected (except with two or three exceptions) to furnish crystals in any paying quantities. (Table C, page 508.)

4th. Those sirups which would not crystallize as well as those which would were of good color, body, and taste, and well adapted for cooking purposes. They found ready sale at 33 cents per gallon for the whole lot.

5th. The reason assigned for the poor quality of the canes, and, consequently, the low percentages of crystallizable sugar in the sirups, is that the sorghum seed were thrice planted, in consequence of cold weather and the ravages of cut-worms. These circumstances prevented the cane from being sufficiently mature when the time for working came.

Very respectfully,

HENRY B. PARSONS, *Assistant.*

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ADDITIONAL WORK OF THE DIVISION.

In addition to these investigations of sorghum and maize, the chief work of this division has been as follows:

1. Examination of the various methods for the analysis of phosphoric acid in fertilizers.
2. Examination of commercial glucose and grape sugar.
3. Analyses of sea-weeds.
4. Analyses of soils and peats.
5. Proximate analyses of "poison sage" and of seeds of "Spanish buckeye."
6. Proximate analyses of grasses, feed-stuffs, fodder, and vegetables.
7. Examinations of 32 samples of wheat.
8. Analyses of maize and sorghum as fodder plants.
9. Analyses of ensilage.

Besides the above, there have been made a large number of analyses of mineral and potable waters; of samples of fertilizing materials, as marls and fertilizers; of soils and kaolins, and assays of numerous ores of gold, silver, lead, nickel, copper, and iron, and of coal; as also of various minerals submitted to this division for examination.

In addition to the above work of this division, the amount of correspondence has steadily increased, and to such an extent as to require nearly the entire time of one person to attend to the same, concerning matters which, though requiring no analytical work, are yet legitimate subjects of inquiry from the agricultural community.

It appears most desirable that for such purpose provision be made by the appointment of a clerk to whom such correspondence could be deputed.

The demand for better laboratory facilities for the proper performance of the increasing work devolving upon this division of the department becomes more imperative, as also for an increased force of assistants.

EXAMINATION OF METHODS FOR THE DETERMINATION OF PHOSPHORIC ACID IN ITS VARIOUS FORMS IN FERTILIZERS.

In accordance with the request of the committee appointed at the Cincinnati meeting of agricultural chemists, the examination of the action of oxalate of ammonia on various commercial fertilizers, according to the schehule supplied by them, has been carried out with the results given in the accompanying table.

TABLE I.—*Showing the varying action of oxalate.*

	Weight of substance taken.	Weight of oxalate taken.	Volume of solution.	Time of digestion.	Temperature of digestion, centigrade.	Precipitate phosphate, 25.			Navassa acid, 12.			Navassa acid, 39.			Navassa raw, 38.			So. Car. acid, 41.			So. Car. raw, 40.		
								P_2O_5 undiss.			P_2O_5 undiss.			P_2O_5 undiss.			P_2O_5 undiss.			P_2O_5 undiss.			P_2O_5 undiss.
Total P_2O_5						45.50			15.75			16.18			29.64			18.61			26.49		
Soluble P_2O_5									1.30			4.47						11.09					
Insoluble in citrate P_2O_5									6.50			6.25						5.90					
CONCENTRATION OF SOLUTION.																							
	2.	5.	100.	60′	100°								3.05	3.37			24.78			3.52			22.30
	2.	4.	100.	60′	100°			21.33			8.62			6.17			25.57			4.17		24.51	24.06
	2.	2.	100.	60′	100°			27.88			10.63			7.94			27.18			5.62			24.64
	2.	1.	100.	60′	100°			34.16			12.18			9.59			28.43			6.52			25.07
RATIO OF SOLUTION TO SUBSTANCE.																							
	2.	2.	200.	60′	100°									7.54			26.57			5.77			24.39
	2.	2.	100.	60′	100°									7.97			27.53			6.07			24.65
	2.	2.	50.	60′	100°									8.84			28.00			7.35			24.74
TIME OF DIGESTION.																							
	2.	2.	100.	120′	100°									8.01			26.54			5.27			24.00
	2.	2.	100.	60′	100°												27.09			5.98			24.37
	2.	2.	100.	30′	100°									9.67			27.99			6.36			24.59
TEMPERATURE OF DIGESTION.																							
	2.	2.	100.	60′	100°						4.85			7.88			27.18			5.84			24.08
	2.	2.	100.	60′	100° c.d*									8.65						6.06			24.70
	2.	2.	100.	60′	90°						9.46			10.56			28.67			6.81			24.98

* Cooled down from 100° C. for 1 hour.

The conclusion from these results is that the amount of phosphoric acid dissolved, or of so-called "reverted" phosphoric acid present, is dependent entirely on conditions, varying in all cases according to the dilution of the reagent, temperature of treatment, and time during which the action of the solvent is continued. It will be necessary, if this reagent is employed, to decide the exact conditions under which the determination is to be made, and it is evident that in no case would the separation of dicalcic from tricalcic phosphate be an exact chemical one, as some tricalcic phosphate is probably dissolved under any circumstances. In addition to these results, others were obtained with the same superphosphates and several native phosphates and specimens of ground bone.

The reagents which were employed were—

1. The ordinary citrate of ammonium solution, neutral, specific gravity 1.09.
2. A solution of the acid citrate of ammonium of specific gravity 1.09.
3. A solution of the citrate of ammonium of the above specific gravity, made strongly alkaline with ammonia.
4. A solution of neutral citrate of ammonium, prepared by neutralizing the acid citrate with carbonate of ammonium, according to the method of Herzfelst and Feuerlein.
5. A solution of oxalate of ammonia, containing five grams of the salt to the liter.
6. A solution of oxalate of ammonia, containing five grams to the liter, made strongly alkaline with ammonia.

Attempts to employ acids in a diluted form were failures, as is shown by one or two experiments with citric acid. From the determinations given in the accompanying tables it is plain that the action of these reagents is different, but that the amount dissolved is still for all of them a function of the time, temperature, and concentration, as was found to be the case with oxalate from our results in the first series of experiments. All the reagents, too, have a decided solvent action on tricalic phosphate found in most of those native phosphates, guanos, and bones which were employed. Only the very hardest sorts of mineral phosphates, like apatite, resist the action of even the mildest solvents. The action of acid, neutral and alkaline citrate, presents some unexpected results. While it has been shown that in the case of ordinary bone superphosphates the acid citrate dissolves more than the neutral, and the neutral more than the alkaline, the contrary takes place with ferruginous phosphates like the navassa, and the most phosphoric acid is dissolved by the alkaline citrate. This shows the necessity for adapting our methods to different kinds of fertilizers, and that one method is not suitable to all.

The results bring out many more points which are evident after a careful examination, and among them the fact that the amount of ferric phosphate which is dissolved in the navassa phosphate is never definite, but varies, as has been shown to be the case with the total amount dissolved, according to the conditions of treatment. From this it becomes apparent how very difficult any accurate analysis of a navassa phosphate is, for we are dealing with a far more complicated mixture than is found in an ordinary acid bone phosphate. As yet no method has been proposed which can furnish anything more than the merest empyrical results in the case of anything but pure bone phosphate and similar material free from iron.

Neutral salts of citric and oxalic acid appear to furnish the best solvents, or those to be most depended on. A proper modification of the oxalate method, however, with the understanding that the strength of solution must be varied for such phosphates as the navassa, or perhaps the time of digestion increased, which amounts practically to the same thing, seems from the greater certainty of procuring the neutral oxalate in definite condition, from the greater ease of filtration, and more convenient temperature of working, to be the best method for universal adoption until something better can be suggested which shall overcome the many sources of error which are present in all the methods of working which have been used up to the present time.

A few of the determinations given in the column headed "Dissolved phosphoric acid" were made by precipitating directly according to the method of Petermann. Under proper regulations of condition this seems to furnish accurate results, but there is such a liability to precipitation of lime and magnesia that it is hardly to be depended on in comparison with the accuracy of the molybdate method.

At the present time the agricultural or crop-producing value of this reverted phosphoric acid, so called, as compared with the soluble phosphoric acid of a superphosphate, or of the tricalcic phosphate as found in bone meal, still remains a matter of grave doubt, even in the minds of the best informed, and a series of experiments in the field which should throw light upon this important question would appear most desirable. Certain experiments already reported appear to show that, upon certain soils at least, this reverted phosphoric acid is more valuable in increasing the crop than the soluble.

TABLE II.—*Action of reagents on navassa acid phosphate No. 12.*

Reagent.	Treatment.	Wt.	Vol.	Time.	Temp.	Dissol. P_2O_5.	Undissol. P_2O_5.	Sum.	P_2O_5 with Fe. undis.	Total P_2O_5 with Fe.	Total P_2O_5.
				h. m.	°*C.*						
Water, soluble	Percolation	2	500		Air.	1.34					
	do	2	500		Air.	1.28					
	Digestion	2	1,000	2	Air.	1.00					
Total	Ignition	2									15.13
	do	5								5.94	14.46
	do	2								5.85	15.50
	Without ignition	2								5.80	15.90
	do	2									15.75
Citrate, acid	After percol	2	50	30	40		14.44				
	do	2	100	30	40		8.03		2.88		
	do	2	100	30	40		7.98		2.21		
	do	2	100	60	90		5.38				
Citrate, neut	After percol	2	50	30	40		9.98				
	do	2	100	30	40		6.73		1.59		
	do	2	100	30	40		6.69				
	do	2	100	30	40	6.87	6.40	14.51			
	do	2	100	60	90		5.21				
	do	2	100	18 hrs.	40		2.87				
Citrate, alk	After percol	2	100	30	40		5.20		2.17		
	do	2	100	30	40		5.63		2.15		
	do	2	100	13 hrs.	40		3.02				
Citrate, Herz and Feuer	After percol	2	100	30	40	8.97	6.97	15.94			
Citric acid ½ per cent	After percol	2	400	2 hrs.	Air.		12.05		5.32		
Oxalate, neut	Before percol	2	100	30	40		10.30		4.02		
	do	2	100	30	90		6.62		2.27		
	do	2	100	60	90		5.87		2.52		
	After percol	2	100	60	40		9.46				
	do	2	100	18 hrs.	40		4.38				
	do	2	100	60	90		4.32		2.54		
	do	2	100	60	90		4.35				
	do	2	100	30	90		4.32		1.30		
Oxalate, alk	Before percol	2	100	30	40		11.30		4.10		
	do	2	100	30	90		10.92		5.65		
	do	2	100	60	90		10.62		3.25		
	After percol	2	100	18 hrs.	40		8.68				
	do	2	100	30	90		7.02		4.97		
	do	2	100	60	90		7.10		4.30		

TABLE III.—*Action of citrate and oxalate of ammonia on acid phosphates.*

Phosphate.	Reagent.	Vol.	Wt.	Time.	Temp.	Dissol. P_2O_5.	Undissol. P_2O_5.	Sum.	Total P_2O_5.
				h. m.	*°C.*				
Navassa acid, 13	Soluble	500	2	Percol.	Percol.	1.8			
	Acid citr	50	2	30	40		14.31		
	do	100	2	60	90		4.84		
	Neut. citr	50	2	30	40		12.79		
	do	100	2	60	90		4.33		
	Neut. oxal	100	2	60	90		8.14		
Total									15.47
Navassa acid, 18	Soluble	500	2	Percol.	Percol.	7.37			
	do	500	2	do	do	7.47			
	Neut. citr	100	2	30	40		5.15		
	Alk. citr	100	2	30	40		4.25		
	Citric acid	400	2	4	Air.		8.10		
	Neut. oxal	100	2	30	90		8.50		
	do	100	2	60	90		6.15		
	Alk. oxal	100	2	60	90		6.50		
Total									19.24
Navassa guano, 20	Soluble	500	2	Percol.	Percol.	1.98			
	Neut. citr	100	2	30	40	3.85	6.40	12.23	
	Alk. oxal	100	2	60	90	3.08			
Total									12.48
Green Mt. sol., 21	Soluble	500	2	Percol.	Percol.	14.32			
	do	500	2	do	do	14.57			
	do	500	2	do	do	15.30			
	do	1,000	2	2	Air.	14.95			
	do	1,000	2	2	Air.	15.35			
	do	1,000	20	2	Air.	14.64			
	Neut. citr	100	2	30	40		.28		
	Alk. citr	100	2	30	40		Trace.		
	Neut. oxal	100	2	60	90		.10		
	Alk. oxal	100	2	60	90		Trace.		
Total									16.35
Moore's supernitrated, 16	Soluble	500	2	Percol.	Percol.	2.69			
	Neut. citr	100	2	30	40		4.63		
	Alk. citr	100	2	30	40		6.36		
	Neut. oxal	100	2	60	90		4.79		
	Alk. oxal	100	2	60	90		9.14		
Total									12.68

TABLE IV.—*Action of citrate and oxalate of ammonia on bone and precipitated phosphates.*

Phosphate.	Reagent.	Wt. of phosph.	Vol. of reagent.	Time of digest. (h.)	Time of digest. (m.)	Temp. of digest. (° C.)	P_2O_5 dissol.	P_2O_5 undissol.	Sum.	Total P_2O_5.
Coarse bone	Neut. citr	2	100		30	40		21.24		
	Alk. citr	2	100		30	40		21.03		
	Neut. oxal	2	100		60	100	3.06			
	Alk. oxal	2	100		60	100	.00			
Total										21.95
Precipitated	Neut. citr	1	100		30	40		19.18		
Calcic phosphate	Neut. citr	1	100	18		40		4.18		
Commercial	Alk. citr	1			30	40		24.56		
$Ca_3(PO_4+)_2+Ca_2H_2(PO_4)2$	Alk. citr	1	100	18		40		12.09		
	Herz and F. citr	1	100		30	40	28.35	17.80	46.15	
	Neut. oxal	1	100		60	100		15.60		
	Neut. oxal	1	100	16		40		3.77		
	Alk. oxal	1	100		60	100	22.86	22.60	45.46	
	Alk. oxal	1	100		120	100		22.50		
	Alk. oxal	1	100	16		40		6.65		
	Alk. oxal	1	100	16		90	37.10			
Total										45.50
Precipitated	Neut. citr	1	100		30	40		Traces		
Calcic phosphate $Ca_2H_2(PO_4)2$	Alk. citr	1	100		30	40		Traces		
	Neut. oxal	1	100		60	100		.27		
	Alk. oxal	1	100		60	100		7.70		
	Alk. oxal	1	100		120	100		7.24		
Total										28.78

TABLE V.—*Action of citrate and oxalate of ammonia on native phosphates.*

Phosphate.	Reagent.	Weight of phosphate.	Volume of reagent.	Time of digest.	Temperature of digest.	Dissol. P_2O_5.	Undissol. P_2O_5.	Sum.	Total P_2O_5.	Condition.	Number.
				h. m.	° C.						
Apatite	Neut. citr		100	30	40	Traces	40.35			Fine ground	26
	Alk. citr		100	30	40		39.85				
	Neut. oxal		100	60	100		38.60				
	Alk. oxal		100	60	100						
Total									40.74		
Logrosan phosphate	Neut. citr	2	100	30	40	.15	34.40	34.55		Fine ground	28
	Alk. citr	2	100	30	40		31.15				
	Neut. oxal	2	100	60	100		31.85				
	Alk. oxal	2	100	60	100		34.10				
Total									34.50		
Spanish phosphate	Neut. citr	2	100	30	40	Traces	24.14			Fine ground	29
	Alk. citr	2	100	30	40		24.72				
	Neut. oxal	2	100	60	100	1.22	23.15	24.87			
	Alk. oxal	2	100	60	100		24.40				
Total									24.72		
Rhenish phosphate	Neut. citr	2	100	30	40	Traces	17.15			Fine ground	30
	Alk. citr	2	100	30	40		17.39				
	Neut. oxal	2	100	60	100		16.10				
	Alk. oxal	2	100	60	100		16.09				
Total											
Curaçoa phosphate	Neut. citr	2	100	30	40	.51	36.65	37.16		Fine ground	35
	Alk. citr	2	100	30	40		37.45				
	Neut. oxal	2	100	60	100	2.51	34.65	37.16			
	Alk. oxal	2	100	60	100		37.25				
Total									37.05		
Navassa phosphate	Neut. citr	2	100	30	40	1.54	34.15	35.09		Fine ground	36
	Alk. citr	2	100	30	40						
	Neut. oxal	2	100	60	100	2.65	32.35	36.00			
	Alk. oxal	2	100	60	100		33.29				
Total									36.10		

Copralites phosphate	Neut. citr	2	100	30	40	.80	23.17			Fine ground	27
	Alk. citr	2	100	30	40		24.01				
	Neut. oxal	2	100	60	100	2.96	20.75				
	Alk. oxal	2	100	60	100		23.44				
Total									24.20		
South Carolina ground rock	Neut. citr	2	100	30	40					Fine ground	24
	Alk. citr	2	100	30	40						
	Neut. oxal	2	100	60	100		21.65				
	Alk. oxal	2	100	60	100						
Total									25.70		
South Carolina ground rock	Neut. citr	2	100	30	40	2.19	24.37	20.56		Fine ground	30
	Alk. citr	2	100	30	40		25.90				
	Neut. oxal	2	100	60	100	4.01	21.45	25.46			
	Alk. oxal	2	100	60	100		24.85				
Total									26.48		
South Carolina rock dust	Neut. citr	2	100	30	40	2.62	25.67	28.29		Dust	31
	Alk. citr	2	100	30	10		27.45				
	Neut. oxal	2	100	60	100		23.35				
	Alk. oxal	2	100	60	100		26.41				
Total									28.84		
Orchilla guano	Neut. citr	2	100	30	40		13.50			Native state	33
	Alk. citr	2	100	30	40		16.31				
	Neut. oxal	2	100	60	100	4.61	12.00				
	Alk. oxal	2	100	60	100		14.10				
Total									17.70		
Morant Keys guano	Neut. citr	2	100	20	40					Native state	34
	Alk. citr	2	100	30	40		9.27				
	Neut. oxal	2	100	60	100	2.10	6.75				
	Alk. oxal	2	100	60	100		9.18				
Total									11.05		

"GLUCOSE" SUGAR.

From corn-starch there is produced in this country two substances called glucose and grape sugar, which are sold in large quantities, both for manufacturing purposes and for private consumption. "Glucose," so-called, is a very thick transparent sirup, while "grape sugar" is a white substance, resembling tallow or spermaceti in appearance, in its crude condition. They both have a sweet taste, easily distinguishable from cane sugar. The question has arisen whether these substances are injurious to health, and it has been affirmed that it is not always possible to remove completely the acid used in its manufacture. If the acid were not completely removed, as it very easily may be, the production of a white article would be impossible. The appearance of the sugars will always vouch for their purity in this respect. As to what other substances injurious to health are present, one must judge from the following analyses:

	Glucose sirup.	Grape sugar.
Dextrose	43.52	63.02
Unfermentable substance	40.72	20.14
Water	15.62	16.64
Ash	.14	.20
	100.00	100.00

Disregarding the water and ash, the latter being too small in amount to be of any injury, there remains in the sirup and sugar dextrose and an unfermentable substance. Pure dextrose, or glucose, as it is also called, is produced by the action of acids upon starch. If, however, the action of the acid is stopped before the complete conversion of the starch to glucose, there will be found intermediate products, such as the unfermentable substance mentioned above. Dextrose itself is readily converted by ferments into alcohol, but the unfermentable substance is not, and, where these artificial sugars are used in brewing, this substance will remain in the beer as such.

It will be noticed that the sirup contains twice as much unfermentable substance as the solid sugar.

Aside from their use by brewers, there seems to be no reason why, where no deceit is practiced in their sale, both glucose sirup and grape sugar should not be perfectly healthy articles of diet when taken in moderation. It is only when deceit is intended and more expensive articles, like cane sugar, are adulterated, that the sale or use of these new products can be reprobated. A more complete examination of the composition and properties of this unfermentable portion of these sugars may be found in Fresenius Zeitschrift für analytische Chemie, 1876, p. 188, in an article by C. Neubauer on the addition of grape sugar to wine.

SEA-WEEDS.

The immense amount of rock weed and kelp which can be gathered along our coast make any means of utilizing it very much to be desired. At present along the New England coast the farmers find it of great value as a fertilizer when applied to corn and other crops, owing to its content of nitrogen, potash, and soda. The following analyses of the ash show the relative proportions of these valuable materials in one of the commoner varieties:

HE ROCK WEED (*Ascophyllum nodosum*).

The air-dry weed contains:

	Per cent.
Water	15.55
Ash	16.28
The latter consisting of—	
Insoluble	1.67
Iron oxide, Fe_2O_3	.66
Manganic oxide, Mn_3O_4	.69
Calcium oxide, CaO	10.52
Magnesia, MgO	8.89
Potash, K_2O	14.36
Soda, Na_2O	23.80
Phosphoric acid, P_2O_5	1.82
Sulphuric acid SO_3	29.18
Chlorine, bromine, and iodine, Cl.Br.I as Cl	8.41
	100.00

The remaining varieties, which are common north of New York, contain in the air-dry weed:

	K_2O.	Na_2O.	P_2O_5.	N—.
She Rock Weed (*Fucus vesiculosus*)	1.031	4.746	.320	.66
Ribbon Kelp (*Lammaria saccharina*)	7.557	4.361	.486	.92
Shoe-String Kelp	6.299	2.713	1.092	1.68
Coral Moss (*Chondrus crispus*)	1.956	4.589	.384	1.23
And, calculated on the same basis:				
He Rock Weed (*Ascophyllum nodosum*)	2.341	3.880	.296	.56

The kelps contain the most nitrogen, and at the same time more of the valuable ash ingredients than the rock weeds, and are by far the most valuable as fertilizers. A ton of ribbon kelp in an air-dry state would be worth to the farmer, according to the average prices for phosphoric acid, potash, and nitrogen, about $11; which shows that in localities where it can be collected in amount it will pay for hauling.

The value of many sea-weeds as nutrients has been known for a long time in China and the East, and in our own country large amounts of chondrus are collected every year, which is sold under the name of Irish moss, and used for the manufacture of jellies and similar articles, where its gelatinizing properties can be made advantageous. In the British Isles, along some portions of the coast, the sea-weed has been collected for many years and used as a fodder. The possibility of the application in this direction of the weeds of our coast depends merely upon their nutritive properties and the removal of a certain rank taste which the fresh weed always carries with it. That the nutrients contained in our common rock weeds are abundant and valuable appears in an analysis of a mixture of He and She Rock Weed.

PROXIMATE ANALYSIS OF FUCUS VESICULOSUS AND ASCOPHYLLUM NODOSUM, MIXED.

AIR-DRY SUBSTANCE.

Water	15.55
Ash	16.27
Ether Extract:	
Oil	7.36
Green color (thallochlor)	46
Brown wax	1.18
Alcohol extract, 80 per cent.	
Brown leathery resin	7.69
Mannite (and organic acids)	11.90
Water extract:	
Sea-weed mucilage	14.80

Acid extract:	
(?) (Glucose equivalent, 8.60)	10.00
Undetermined soluble in alkali	7.19
Insoluble in acids and alkali	4.10
Nitrogen×6.25	3.50
Total	100.00

The oil which is present to the amount of 7 per cent. is at first very rank and disagreeable, but on exposure to the air this odor is lost entirely, and instead there is only perceived that which is peculiar to olive or other similar oils. It is a non-drying oil, not solidifying at —15° C., and giving no marked reactions with the usual reagents. Specific gravity, .931 at 15° C.

The alcohol extract, on evaporation and subsequent treatment with water, gives a solution from which mannite crystallizes with great ease, and, being present in so large amount, naturally forms one of the most valuable constituents of the plant. Its presence has been shown in the kelps and some other algæ, and it is not surprising that it occurs in the rock weeds.

The substance insoluble in water, but soluble in alcohol, is similar in character to the general nature of the fresh weed. It is, perhaps, one of the substances which assist in giving the weed its leathery aspect, and, together, the large amount of mucilage found in the water-extract, its power of swelling up after drying when soaked in water.

Of what the acid extract consists it is difficult to say. The resulting substance reduces Fehling's solution, and probably possesses a nutritive value equal to the similar extract in land plants.

There is no true cellulose in the plant. Its place is substituted by a substance of a slimy nature, which dries up into a horny mass. The presence of so much oil, gum, and mannite, together with the absence of a hard fibrous structure, point to an opportunity for the profitable use of such weeds for food in combination with others of a more highly nitrogenous nature, if it is possible to remove the excess of salt and the rank taste by boiling, steaming, or some other method.

Mr. Murray, of New York, informs the department that he has for some time been in the habit of preparing the rock weeds in a palatable condition for use upon the table, and, if this is a possibility, it does not seem too much to expect that they may be adapted to consumption by cattle.

SOILS.

Two soils from Texas, which were sent to the department for the purpose of discovering the reason why one should cause rust upon the cotton and the other not, have been analyzed. The results show how little information can be derived from analyses of this kind.

Soils from Geo. Pfeuffer, New Braunfels, Texas.

[No. 1, not rusting the cotton. No. 2, rusting cotton.]

	No. 1.	No. 2.
Moisture	8.42	6.43
Organic matter	11.08	6.86
Insoluble	56.30	61.17
Silica	9.25	7.93
Iron and alumina	11.94	13.36
Manganese	.53	trace.
Lime	1.55	2.11
Magnesia	.75	.63
Potash	.14	.33
Soda	.00	trace.
Phosphoric acid	.06	.04
Sulphuric acid	trace.	trace.
Chlorine	.06	.03
CO_2	....	.89
	100.07	99.75

From an inspection of these results it appears that they differ no more than might be expected in different parts of the same field, and that, aside from the fact that the injurious soil contains a small amount of manganese, and the good soil a small percentage of carbonates, they both appear to be deficient in sulphates and to a smaller extent in lime, magnesia, and phosphoric acid. The addition of these elements to the soil might prove beneficial, but it is probable that insufficient drainage in some of the lower parts of the field, or other physical causes, may have been as active in producing rust as any lack of presence of any particular substances.

PEATS.

[From W. J. Lewis, West Brook, Conn.]

Analyses of two peats from this source are published.

[A. Surface peat, air-dry. B. 2 feet below surface, air-dry.]

	A.	B.
Water	11.65	11.25
Ash	7.10	6.65
Ferrous salts	none.	none.
Potash and soda	traces.	traces.
Phosphoric acid	.15	.78
Nitrogen	.87	1.40

The above analyses fairly represent the average composition of this material, many samples of which are sent to the Department for analysis.

Generally an experiment with a sample, using it as a top-dressing upon grass lands, or for other crops, will prove its value far better than the results of analysis.

PROXIMATE ANALYSIS OF ZYGADENUS PANICULATUS.

(The Poison Sage of the Indians.)

[Collected by Marcus E. Jones. Utah, 1879.

The air-dry bulbs of this plant, which are said to be very poisonous, contain—

Water		7.10
Ash		14.73
Oil		4.15
White wax		5.30
Resinous matter and color		21.64
Organic acids, sugar, 1.30 per cent.		
Alkaloid, amides, &c., undetermined		7.82
Gum		7.10
Acid extract		7.24
Undetermined alkali extract		3.07
Fiber (?)		10.10
N. × 6.25		11.75
Total		100.00
Per cent. of nitrogen	1.88	
Per cent. of non-albuminoid nitrogen	.48	
Per cent. of nitrogen as non-albuminoid	25.5	

The petroleum ether extract of the bulbs on evaporation leaves a beautiful white wax, mixed with a yellow oil, the former melting very easily. No detailed examination was made of them.

In the alcohol extract were detected several substances, but, owing to the small amount of material which was at hand, their separation was not attempted.

Of the .48 per cent. of nitrogen which it contains, a portion at least is in the form of an alkaloid, as shown by several alkaloid reagents. Organic acids forming insoluble lead salts are present in small amount, as well as glucose. The chief constituent, however, seems to be a resinous extractive amounting to 21.64 per cent.

The remaining constituents of the plant call for no explanation, and it only remains at some future time, with a larger supply, to study the alcoholic extract of the bulb. As the plant belongs to a family in several members of which alkaloids of a very poisonous nature have been found, the trace of alkaloid detected in Zygadenus is undoubtedly the cause of its poisonous properties.

UNGUADIA SPECIOSA.

The seeds of this plant, which is known in Texas as "Spanish Buckeye," have been sent to the Department from Jasper, Jasper County, Texas, by Mr. L. C. White. An examination shows that they contain a light-colored oil to the extent of 27.4 per cent. of the seed, which, if they can be collected in sufficient quantity, may furnish a supply of some importance commercially. The very limited amount of nuts prevented an examination of the properties of the oil.

GRASSES, FEED, FODDER, VEGETABLES, &c.

In the report of this Department for 1880, a series of analyses is given of various grasses, showing the changes which take place during their development, as far as it was possible to do so from the determinations there given.

To extend our observations, Meadow Fox Tail (*Alopecurus pratensis*) has been submitted to a more complete course of proximate analysis.

TABLE VI.—*Analyses of Alopecurus pratensis at four stages of growth.*

Constituents.	Head appearing.		Before bloom.		In bloom.		After bloom.	
When cut	April 19.		April 19.		May 1.		May 12.	
Water in fresh grass	77.1		76.7		60.00		60.6	
Air-dry substance:								
Water	8.75	8.75	9.83	9.83	7.70	7.70	8.58	8.58
Ash	8.40	8.40	7.12	7.12	7.15	7.15	7.47	7.47
Ether extract	4.28		4.02		3.10		3.20	
Soluble in alcohol		3.40		3.07		2.25		2.35
Insoluble in alcohol		.88		.95		.85		.85
Eighty per cent. alcohol extract	16.86		12.69		11.65		10.20	
Insoluble in water		1.46		1.75		1.53		1.24
Soluble in water:								
Sugars		3.40		2.40		2.70		2.70
Organic acids, &c		8.67		5.28		7.42		5.98
Amido bodies		2.83		2.26		.00		.28
Water extract	3.02	3.02	2.06	2.06	1.68	1.68	1.64	1.64
Acid extract	15.70	15.70	20.50	20.50	21.60	21.60	20.50	20.50
Alkali extract (difference)	16.24	16.24	15.33	15.33	15.19	15.19	17.74	17.74
Crude fiber	16.62	16.62	20.20	20.20	21.95	21.95	23.18	23.18
Albumen	10.63	10.63	9.25	9.25	9.98	9.98	7.49	7.49
Dry substance:								
Ash	9.21	9.21	7.90	7.90	7.75	7.75	8.17	8.17
Ether extract	4.69		4.46		3.36		3.50	
Soluble in alcohol		3.73		3.40		2.44		2.57
Insoluble in alcohol		.96		1.05		.92		.93
N. free extract	52.16		51.66		54.30		54.35	
Eighty per cent. alcohol extract:								
Insoluble in water		1.60		1.94		1.65		1.36
Soluble in water:								
Sugars		3.73		2.66		2.92		2.95
Organic acids, &c		9.50		5.86		8.04		6.54
Amido bodies		3.10		2.50		.00		.34
Water extract		3.31		2.28		1.82		1.79
Acid extract		17.20		22.74		23.41		22.42
Alkali extract (difference)		16.79		17.00		16.46		19.41
Crude fiber	18.21	18.21	22.41	22.41	23.78	23.78	25.36	25.36
Albumen		11.76		10.26		10.81		8.19
Nitrogen × 6.25	15.78		13.58		10.81		8.62	
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total nitrogen	2.52		2.17		1.73		1.33	
N. as albumenoid	1.86		1.64		1.73		1.26	
N. as non-albuminoid	.66		.53		.00		.07	
Per cent. N. as non-albuminoid	38.2		40.9		.00		5.00	
Nutritive ratio	1:4.8		1:5.8		1:7.5		1:9.7	

The results give a closer insight into the composition of this grass than it was possible to obtain from our previously limited work.

Our former conclusions were as follows:

As the plant advances in growth the water in the fresh grass decreases; and in the dry substance the ash decreases, the fat decreases, the albumen decreases, while the fiber increases and the nitrogen free extract increases.

These same results are shown in the analyses which we have at present under consideration, and, in addition, it becomes plain that the alcohol extract, which contains the sugars, organic acids, resins, amide bodies, and other "extractives" so called, is larger in the young than in the old plant. The question then arises, What substances among these diminish with the increasing age of the plant? It would be expected that the sugars would increase. On the contrary, they appear to decrease. Under the head of sugars, however, may be included other reducing substances which have acted upon the Fehling solution used for the determination of the sugars. After defecation with lead the amide substances are the only ones which could produce such a result, and they undoubtedly introduce a slight error; but in the two first examples, while the amount of amide bodies varies only slightly that of the sugars or apparent sugar decreases one per cent., so that we are justified in assuming an actual decrease.

Those substances in the alcohol extract which are insoluble in water, consisting of resinous and extractive matters, are of little importance from other than a physiological point of view. They appear to undergo little change in amount.

In addition to the sugars, that portion of the alcohol extract soluble in water contains the amide substances of the plant, which increase with its course of development; and those substances, largely organic acids and coloring matter, which are precipitated by lead and decrease in the latest stages of growth. From the water extract we find that the amount of gum is much larger in the earlier stages of growth, and this has been found to be so in other plants which we have analyzed.

That portion of the plant which is removed by acid and alkali is greater in the later stages of growth, as is also true of the fiber.

If our conclusions fail to be entirely satisfactory in showing that period in which the plant is most valuable for feeding purposes, it has at least thrown some light on some of the changes which must be taken into consideration in a future examination of the subject.

The differences in composition which are brought about in the same species of grass by changes in method of cultivation and character of the soil was shown in a series of analyses of Dactylis, given in the last report of this division.

This year a set of phleum pratense and two samples of trifolium pratense, which were collected by Mr. J. W. Sanborn, at Hanover, N. H., have been analyzed, and the results are presented in the following table, together with the similar specimens analyzed last year among our collection of grasses grown in Washington:

TABLE VII.—*Comparison of Phleum and Trifolium from Washington and New Hampshire.*

Development.	Trifolium pratense.				Phleum pratense.										
	Washington.		New Hampshire.		Washington.						New Hampshire.				
	In full bloom.	After bloom.	In full bloom.	After bloom.	Spike invisible.	Spike visible.	Before bloom.	Early bloom.	Full bloom.	Early seed.	Spike invisible.	Spike visible.	In bloom.	After bloom.	Early seed.
Water	8.55	8.36	7.40	5.80	7.85	8.80	6.80	5.60	6.30	5.95	7.50	7.00	6.00	7.10	6.50
Ash	7.60	6.64	6.90	7.70	8.00	5.85	9.15	5.70	5.30	9.90	4.80	4.40	4.30	3.60	3.00
Fat	4.38	7.23	7.02	3.98	4.20	3.10	3.38	3.63	3.35	3.20	4.25	5.92	3.95	3.00	2.58
N. free extract	41.42	45.94	45.82	50.29	50.05	52.22	50.51	54.01	55.22	47.09	52.81	52.17	53.73	54.55	58.52
Crude fiber	14.55	18.25	17.30	18.73	18.35	19.18	20.53	21.43	20.55	22.48	21.70	23.57	26.58	26.87	24.34
Crude albumen	17.50	16.58	15.56	13.50	11.55	10.85	9.63	9.63	9.28	11.38	8.94	8.94	5.44	4.88	5.06
Dry substance:															
Ash	8.31	7.25	7.45	8.17	8.68	6.41	9.82	6.04	5.66	10.53	5.19	4.73	4.57	3.88	3.2
Fat	4.79	4.62	7.58	4.23	4.56	3.40	3.63	3.85	3.58	3.40	4.60	4.22	4.20	3.23	2.7
N. free extract	51.85	50.13	49.49	53.39	54.31	57.26	54.19	57.21	58.93	50.07	57.09	56.10	57.16	58.72	62.5
Crude fiber	15.91	19.91	18.68	19.88	19.91	21.03	22.03	22.70	21.93	22.90	23.46	25.34	28.28	28.92	26.03
N. × 6.25	19.14	18.09	16.80	14.33	12.54	11.90	10.33	10.20	9.90	12.10	9.66	9.61	5.79	5.25	5.41
Total nitrogen	3.07	2.72	2.69	2.39	2.01	1.86	1.65	1.63	1.58	1.98	1.55	1.54	.93	.84	.87
Non-albuminoid N	1.14	.21	.64	.45	.70	.55	.36	.30	.38	.51	.30	.45	.10	.15	.18
Per cent. N. as non-albuminoid	37.1	7.7	23.8	19.6	35.0	29.5	21.8	18.4	24.0	26.4	19.4	29.2	10.8	17.9	20.7

The New Hampshire soil is much poorer than that of Washington, perhaps not so by nature, but the latter has received a more careful attention and more liberal supplies of manure. The effect is seen plainly in the composition of the grasses. The amount of ash in the phleum, which, indeed, suffers from the poverty of the soil more in all respects than trifolium, is much less than in the Washington sample. The supply of nitrogen, too, appears to have been inadequate, and the proportion of fiber and "nitrogen free substances" in the plant is greater. In the New Hampshire samples the amide nitrogen is lower than in those grown in Washington. From our averages it appears that, as a rule, more nitrogen is present in the non-albuminoid form in the poorer than in the better samples. Here, however, the total amount falls so very low, comparatively, that it is possibly a necessity for it to be all used in the formation of albumen, leaving little to appear in the transitory non-albuminoid form.

In concluding, attention is called to the averages of the composition of American grasses derived from the numerous analyses made in this laboratory during the last three years.

TABLE VIII.—*Average composition of grasses in bloom.*

	American.				German. Wolff's averages.		
	77 analyses of wild grass.	21 analyses of grasses from one farm in Pennsylvania.	19 analyses of grasses from department grounds.	6 analyses of orchard grass from various localities.	Fair.	Good.	Very good.
Ash	7.90	7.95	7.44	7.38	6.30	7.23	8.24
Fat	2.90	3.12	3.52	3.33	2.34	2.92	3.29
N. free extract	53.90	55.75	55.82	55.17	46.53	47.84	48.93
Crude fiber	27.10	23.14	22.47	25.19	34.00	30.69	25.77
Nitrogen × 6.25	8.20	10.04	10.25	8.91	10.74	11.82	13.77
Per cent. N. as non-albuminoid	34.7	30.1	18.3	25.2	....	....	....
Nutritive ratio	1:10.2	1:8.1	1:8.0	1:9.4	1:7.7	1:7.2	1:5.7

American grasses are far from agreeing with the composition assigned by Wolff to those of Germany. The fiber is much less in amount, which is an improvement, while the amount of nitrogen present is not as large even as in the German grasses known as "fair." This of course is a disadvantage to a certain extent, but with the reduced amount of fiber and consequent easier digestibility we can make them as valuable as any German grass by combination with the cheaper forms of nitrogenous fodders. It is a question whether the nutritive ratio demanded by the results of German feeding experiments is not much too narrow, and whether our attention should not be turned more in the direction of bringing about a proper assimilation of carbohydrates. The feeding experiments of Professor Sanborn certainly point in this direction, and in a recent communication he goes so far as to say that it is his conviction that the German feeding tables are extremely misleading and must be put aside. He derives this conviction from six years' experience in exact feeding trials, many of which have covered longer periods than those in Germany and furnished results quite at variance with them.

In the light of this experience too implicit faith should not be placed in the tables of rational feeding of animals, such as are laid down by the German experimenters, for it would appear that with our animals and our grasses, together with other conditions existing with us, the above tables may require some material modification before they are found adapted to this country.

ANALYSES OF FEED STUFFS.

In connection with Professor Sanborn's experiments previously alluded to several feed stuffs have been analyzed and are given here.

TABLE IX.—*Feeding material from J. W. Sanborn, Hanover, N. H.*

	Serial number.									
	329.	330.	330.	331.	332.	362.	363.	364.	365.	366.
		Harns mangel.				Yellow corn.				
	Cotton-seed meal.	Fresh root.	Dry substance.	Wheat bran.	Corn-cob meal.	In kernel.	Clear meal.	Part cob meal.	Cotton-seed meal.	Oat straw.
Water	8.90	91.86	....	11.10	9.20	....	9.86	7.38	7.62	6.53
Ash	8.30	1.07	13.15	6.30	2.60	....	1.92	1.79	6.38	5.77
Fat	15.89	.51	6.29	5.84	.87	....	4.63	3.92	14.54	3.15
N. free extract	19.07	4.08	50.16	50.41	66.68	....	70.36	71.18	15.68	44.26
Crude fiber	4.09	.91	11.12	10.10	18.21	....	2.38	6.63	8.18	35.21
Crude albumen	43.75	1.57	19.28	16.25	2.44	10.85	10.85	9.10	47.60	5.08
Total nitrogen	7.00	.251	3.084	2.60	.39	1.74	1.74	1.46	7.62	.81
Non-albuminoid N	....	.150	1.848	.47	.08	....	....	....	....	.14
Per cent. of N. as non-alb	....	59.7	59.7	18.1	20.5	....	....	....	....	17.3

They present the ordinary composition of such materials as are fed in most parts of our country. The large percentage of non-albuminoid nitrogen usually found in root crops is present in the mangel.

IMPROVED YELLOW-EYED BEANS AND PODS.

Professor Sanborn collected during the summer of 1881 a number of samples of this bean, with its pods, illustrating its different stages of development. The analyses are presented in the following table:

TABLE X.—*Beans and pods from J. W. Sanborn, Hanover, N. H.*

	Serial number.											
	333	335	337	339	341	343	334	336	338	340	342	344
	Beans.						Pods.					
	August 13.	August 22.	August 27.	September 3.	September 10.	September 20.	August 13.	August 22.	August 27.	September 3.	September 10.	September 20.
Average weight of bean	.05	.28	.38	.50	.50	.51	......	......	......	......	......	......
Water	6.80	6.00	4.20	4.50	6.30	6.60	8.50	7.10	7.50	8.70	9.10	7.60
Ash	5.60	5.00	4.70	4.50	4.20	3.80	8.80	8.10	6.40	7.00	7.70	7.20
Fat	1.76	1.96	2.40	2.43	2.30	1.93	1.96	1.46	1.16	1.33	2.66	1.36
N. free extract	52.59	58.48	61.40	57.65	59.45	59.15	47.58	50.47	59.28	52.96	53.57	58.74
Crude fiber	3.40	3.26	3.50	2.90	3.00	3.43	19.53	26.06	22.16	26.13	24.16	21.60
Albuminoids	29.85	25.30	23.80	28.02	24.75	25.09	13.63	6.81	3.50	3.88	2.81	1.50
Total nitrogen	4.42	3.72	3.52	4.12	3.64	3.69	2.18	1.09	.56	.62	.45	.56
Non-albuminous nitrogen	.86	.50	.56	.56	.59	.67	1.31	.45	.06	.20	.06	.11
Per cent. of N. as non-alb.	17.2	13.4	16.0	13.5	16.2	18.2	60.1	41.2	10.7	32.2	13.3	19.7
Dextrine or gum	10.30	6.05	5.38	4.78	1.84	8.65	10.40	14.60	15.50	16.00	15.03	14.30
Sugars and extract	.57	4.87	4.18	4.39	5.81	4.09	8.56	4.93	1.50	2.83	6.96	5.00
Starch, or equivalent	41.72	47.56	51.84	48.48	51.80	46.41	28.12	30.94	42.28	34.13	33.51	39.44
N. free extract	52.59	58.48	61.40	57.05	59.45	59.15	47.58	50.47	59.28	52.96	53.57	58.74
Nitrogen	......	......	......	......	......	......	......	......	......	......	......	......
Insoluble	4.18	3.58	3.33	3.74	3.19	3.53	......	......	......	......	......	......
Soluble in water	.24	.14	.17	.38	.45	.16	......	......	......	......	......	......
Soluble in 80 per cent. alc.	.62	.42	.39	.34	.39	.34	......	......	......	......	......	......
Non-albuminous nitrogen	.86	.50	.50	.56	.59	.67	......	......	......	......	......	......
Total soluble	.86	.50	.50	.72	.84	.50	......	......	......	......	......	......

The conclusions derived from the determination are not of as great value as they might have been under a different method of collection, owing to the fact that in the younger pods, the beans not having been shelled immediately, the one nearest the stem had continued to grow at the expense of the nutrients of the pod after separation from the plant, causing the formation often of one large and well-formed bean among a number of extremely small ones.

The tables, however, present to a certain extent the movement of the nutrients through the pods to the beans. The presence of such a considerable amount of non-albuminoid nitrogen is somewhat unexpected in the beans themselves, but various experiments seem to show that there is a portion existing without doubt in that form.

The average weight of the beans is given in grams, and it may be added that the soil upon which they grew was a heavy clay.

ANALYSES OF VEGETABLES.

A collection of several vegetables from the Washington market, grown in the surrounding country, has furnished the following results:

TABLE XII.—*Vegetables grown in Washington*, 1881.

	302	301	304	305	306	307	308	309	310	311	313	314	315	316	317	318	319	322	321
	Green peas.	Pods of 302.	Blackberries.	Whortleberries.	English cabbage.	Boston lettuce.	Turban squash.	Cr. Neck squash.	Cucumbers.	White onions.	Green pears.	Red beet leaves.	Red beet roots.	Carrot leaves.	Carrot root.	Lemons.	Green apples 1.	Green apples 2.	Stigmata of maize.
ORIGINAL SUBSTANCE.																			
Water	78.06	83.17	88.91	82.42	93.59	95.87	95.18	94.58	95.70	85.26	83.92	88.84	87.68	88.30	87.85	90.22	85.83	82.00	63.53
Ash	.88	.88	.58	.41	.72	.78	.38	.42	.46	.68	.54	2.83	1.05	3.34	1.29	.51	.52	.64	1.73
Ether extract	.55	.53	2.08	3.03	.19	.21	.32	.24	.21	.22	.79	.60	.21	.86	.71	.24	1.24	1.34	1.87
N. free extract	14.48	10.97	5.03	10.31	2.00	1.64	2.95	3.54	1.95	10.80	11.46	2.49	7.64	5.92	6.86	6.90	10.43	14.30	24.33
Crude fiber	1.66	2.91	2.46	3.17	1.44	.53	.53	.54	.65	.76	2.73	2.50	1.69	2.25	2.32	1.31	1.38	1.19	2.92
Crude albumen	4.37	1.54	.94	.66	2.01	.97	.64	.68	.83	2.28	.56	2.74	1.73	4.26	.97	.82	.60	.53	5.52
DRY SUBSTANCE.																			
Ash	4.01	5.22	5.20	2.35	11.25	19.01	7.92	7.60	10.74	4.64	3.35	25.36	8.75	20.00	10.59	5.21	3.67	3.58	4.74
Ether extract (fat and acid)	2.52	3.14	18.79	17.23	3.01	5.08	6.67	4.40	4.99	1.50	4.92	5.41	1.73	5.12	5.86	2.59	8.74	7.42	5.12
N. free extract	65.98	65.18	45.31	58.65	31.26	39.64	61.10	65.47	45.32	73.24	71.27	22.24	61.98	25.53	56.50	70.53	73.60	79.43	66.66
Crude fiber	7.56	17.29	22.19	18.02	22.45	12.85	10.99	9.94	19.56	5.15	16.99	22.43	13.74	35.89	19.10	13.40	9.79	6.61	8.00
Crude albumen	9.91	9.17	8.51	3.75	32.03	23.42	13.32	12.49	19.39	15.47	3.47	24.56	14.00	13.46	7.95	8.36	4.29	2.96	15.48
Total nitrogen	3.19	1.47	1.36	.60	5.13	3.75	2.13	2.00	3.10	2.48	.55	3.93	2.24	2.15	1.27	1.34	.67	.47	2.48
Non-albuminoid N.	.07	.44	.28	.10	3.09	1.85	.66	.62	1.28	1.86	.23	1.47	1.21	.68	.61	.58	.17	.00	.90
Per cent. of N. as non-albuminoid	2.2	30.0	20.6	16.7	60.2	49.3	31.0	31.0	41.3	75.0	41.8	37.4	54.0	31.6	48.0	43.8	25.4	00.0	36.3

The marked points are the large amount of ash in the leaves of the beet and carrot, as well as of nitrogen in the same plants, and in the onion and cabbage. While there is quite a large proportion of non-albuminoid nitrogen in all the vegetables, it is remarkable that in the onion it should rise as high as seventy-five per cent. of the total nitrogen present. The analyses of the green apples were made at two stages of growth; the first when the fruit was from 1½ to 2 inches in diameter and averaged 20 grams in weight, and the second when it was beginning to redden and the pieces were from 2½ to 3 inches in diameter. At the latter point it will be noticed the non-albuminoid nitrogen disappears. An examination of the apples at the first period at which they were collected showed that they contained a large amount of starch, having a very small round grain, a portion of which was easily separated from the expressed juice. The juice at this time had a specific gravity of 1.045, contained 12.39 per cent. of solid matter, of which 6.65 per cent. was glucose and 2.20 per cent. sucrose. The free acid as malic amounted to 1.8 per cent. of the juice. After fermentation for two weeks the free acid calculated as acetic had reached 2.82 per cent.

Unfortunately, there was no opportunity to examine the apples more closely at the second collection.

The ether extract in all the analyses given in the preceding table contains, of course, in addition to the fat and oil, the free acid and much of the coloring matter of the fruit or vegetable, as may be seen in the following more extended examination of the blackberry:

Ash		5.20
Ether extract	18.79	
Insoluble in alcohol		8.68
Soluble in alcohol	10.11	
Insoluble in water		1.94
Soluble in water	8.17	
Acid as malic		.74
Undetermined color, &c		7.43
80 per cent. alcohol extract	25.35	
Insoluble in water		2.17
Soluble in water	23.18	
Sugar		11.50
Organic salts, &c		10.37
Soluble nitrogen substance		1.31
Water extract:		
Gum and pectin		10.95
Acid extract		11.34
Fiber		22.19
Albumen		6.77
		100.59

WHEAT.

At the meeting of agriculturists held at the department during the past winter, Prof. A. E. Blount, of the Colorado Agricultural College, presented a paper upon the cereals, and in it gave an account of his experiments with wheat, and his success in improving by selection, and in producing new varieties by crossing, illustrating the same by forty samples of the wheat which he had grown. On his departure the samples were left at the department for analysis, and the results are tabulated in the accompanying tables.

The methods which were employed in analysis were those described in the report for 1879. The specific gravity was taken on portions of ten grams of the grain in water, in a pyknometer, and may be a trifle too low, owing to absorption of water by the grain, but the filling of the pyknometer with water was done very quickly, and after that was accomplished absorption produced no error.

The weight of 100 grains is of course a function of two qualities, size and density, and the specific gravity being known, an idea of the size may be derived from their weight.

The fresh gluten was determined by kneading twenty grams of the finely-powdered wheat with from twelve to fifteen cubic centimeters of a saturated solution of gypsum, the dough being allowed to stand an hour or more, and then carefully kneaded in water in a porcelain dish, changing the water from time to time, and slowly pouring off that containing the suspended starch. This is readily accomplished in almost all cases, but at times a wheat of more than two years of age, or having little gluten, is difficult to manage in order to keep the gluten itself from washing away. In such a case longer standing of the dough is advantageous.

The "*fresh gluten*," pressed as free from water as possible, was weighed and allowed to dry for a week at about 95° C., after which it is again weighed as "*dry gluten*."

WHEATS FROM COLORADO.

	Blount's Hybrid, No. 10.	720. Blount's Hybrid, No. 15.	721. Blount's Hybrid, No. 16, select.	722. Blount's Hybrid, No. 17.	723. Blount's Hybrid, No. 18.	724. Blount's Hybrid, No. 19, select.	725. Blount's Hybrid, No. 20.	726. Seeds from New South Wales.	727. Centennial.
Number	......	......	......	......	......	......	......	......	726
Color	Amber	Red	Red	Red	......	......	......	Yellow	......
Hardness	Hard	......	Soft	Hard	......	......	......	Hard	......
Weight of 100 grains	......	......	4.824	5.137	......	......	......	4.657	......
Specific gravity	1.397	......	1.331	1.308	......	......	......	1.255	......
Fresh gluten	42.22	32.24	52.92	34.16	32.22	36.96	35.22	28.31	23.80
Dry gluten	14.44	11.38	11.19	11.88	10.74	12.14	11.74	10.64	9.22
Total nitrogen	2.20	1.96	1.88	2.18	2.07	1.99	1.96	2.02	1.93
Moisture	9.72	10.07	9.53	9.93	9.74	10.45	10.57	9.47	9.66
Ash	2.28	1.93	2.04	2.07	2.19	2.54	3.57	2.18	2.35
Fat	2.16	2.68	2.54	3.93	1.58	2.10	2.32	2.40	2.00
Sugar, &c	4.12	2.92	3.38	4.20	3.32	3.44	3.64	4.22	3.06
Dextrine, &c	2.22	2.46	1.90	9.00	1.49	2.68	2.66	3.08	2.10
Starch, &c	61.10	66.12	67.24	53.66	67.23	64.47	63.32	64.68	67.67
Albumen, soluble in alcohol	4.30	3.19	4.26	.80	3.57	3.28	3.71	5.05	4.26
Albumen, insoluble	9.60	9.06	7.49	12.82	9.37	9.10	8.54	7.57	7.80
Crude fiber	1.82	1.57	1.62	1.59	1.60	1.79	1.67	1.55	1.10
Total nitrogen × 6.25	13.75	12.25	11.75	13.62	12.94	12.44	12.25	12.62	12.06

WHEATS FROM COLORADO—Continued.

	728. El Dorado.	729. White Mexican.	730. Judkin.	731. Australian.	732. Fountain.	733. Perfection.	734. Russian.	735. Rio Grande.
Number	6	13	19	22	71	76	15	17
Color	Yellow	....	Red...	Yellow	Yellow	Yellow	Red...	Red...
Hardness	Hard..	....	....	Soft...	Hard..	Hard..	Soft...	Soft...
Weight of 100 grains	4.702	....	....	5.506	5.100	5.536	4.131	5.906
Specific gravity	1.242	....	....	1.305	1.306	1.330	1.311	1.316
Fresh gluten	25.06	42.21	33.59	25.28	35.15	35.36	32.41	35.01
Dry gluten	9.49	14.33	12.10	8.91	11.93	12.07	12.18	12.34
Total nitrogen	1.88	2.21	1.96	1.79	2.18	2.27	2.32	2.35
Moisture	10.55	9.91	9.75	9.78	10.58	9.93	9.55	9.51
Ash	2.24	2.60	2.57	1.85	2.70	1.99	1.99	2.66
Fat	2.43	1.89	2.42	2.23	2.15	2.32	2.62	2.96
Sugar, &c	3.28	3.46	4.96	3.30	2.86	2.84	3.70	2.86
Dextrine, &c	1.82	2.20	2.80	1.92	2.32	1.80	2.20	2.58
Starch, &c	66.83	64.01	63.55	68.28	64.36	65.39	63.96	63.53
Albumen, soluble in alcohol	3.83	4.20	1.97	3.01	3.53	4.34	3.81	3.19
Albumen, insoluble	7.92	9.61	10.28	8.18	10.29	9.84	10.68	11.50
Crude fiber	1.10	1.52	1.70	1.45	1.32	1.55	1.49	1.79
Total nitrogen × 6.25	11.75	13.81	12.25	11.19	13.62	14.18	14.49	14.69

	736. Touzelle.	737. German Fife.	738. Oregon Club.	739. Sonora.	740. Imperial Fife.	741. Lost Nation.	742. Pringle's No. 6.	743. Hybrid No. 7.
Number	21	77	10	12	14	20	83	34
Color	Yellow	Red...	Yellow	Yellow	Yellow	Red...	Yellow	Med'm
Hardness	Med'm	Soft...	Soft...	Soft...	Hard..	Soft...	Med'm	Hard..
Weight of 100 grains	5.214	5.368	4.434	4.739	4.147	3.851	5.145	4.636
Specific gravity	1.301	1.283	1.326	1.344	1.325	1.323	1.304	1.347
Fresh gluten	33.25	38.33	28.92	34.86	39.47	29.52	34.78	33.60
Dry gluten	10.90	14.45	10.06	11.80	14.23	11.23	11.83	12.01
Total nitrogen	2.16	2.41	1.96	2.27	2.55	2.07	2.10	2.49
Moisture	10.23	10.42	9.59	10.17	9.43	10.24	9.80	9.89
Ash	2.10	2.31	1.91	2.02	2.64	2.17	2.13	2.23
Fat	2.35	2.70	2.19	2.13	2.31	2.99	2.52	2.29
Sugar, &c	3.24	2.02	3.10	3.18	4.04	3.52	3.52	2.94
Dextrine, &c	1.88	1.50	1.50	3.00	2.06	2.40	2.20	2.06
Starch, &c	65.05	63.42	67.86	63.93	61.95	64.01	65.85	63.68
Albumen, soluble in alcohol	4.01	4.24	4.34	6.51	5.96	1.64	5.25	3.40
Albumen, insoluble	9.49	10.82	7.91	12.67	9.98	11.29	7.68	11.85
Crude fiber	1.65	1.48	1.60	1.40	1.63	1.74	1.70	1.78
Total nitrogen × 6.25	13.50	15.06	12.25	14.18	15.94	12.93	13.13	15.25

WHEATS FROM COLORADO—Continued.

	744. Clawson.	745. Hedge Row (winter crop).	746. Hedge Row (spr'g crop).	747. White Chaff.	748. Triticum.	749. Durum Russian.	750. Doty.	751. Meekins.
Number	39	41	69	74	79	81	87	88
Color	Yellow	Yellow	Amber	Red...	Yellow	Med'm	Red...	Red...
Hardness	Soft...	Med'm	Hard..	Soft...	Hard..	Hard..	Soft...	Soft...
Weight of 100 grains	4.565	4.072	4.499	4.214	5.754	5.924	4.373	5.193
Specific gravity	1.289	1.357	1.338	1.233	1.316	1.326	1.284	1.293
Fresh gluten	26.91	34.01	30.14	32.24	34.82	37.54	35.81	38.61
Dry gluten	9.99	12.11	10.89	11.37	13.08	13.51	12.52	13.83
Total nitrogen	1.88	2.18	2.07	2.24	2.18	2.44	2.24	2.44
Moisture	10.14	9.07	9.17	9.57	10.02	9.91	9.41	9.38
Ash	1.94	2.08	2.59	2.13	2.67	2.32	2.35	2.53
Fat	2.31	2.11	2.09	2.44	2.65	2.00	2.59	2.97
Sugar, &c	4.10	2.80	3.12	4.80	4.60	4.28	3.68	5.12
Dextrine, &c	2.30	2.02	2.10	2.00	2.84	3.00	2.32	2.04
Starch, &c	65.86	66.68	66.66	62.88	62.09	61.30	63.94	61.17
Albumen, soluble in alcohol	3.44	4.66	4.19	4.89	5.65	6.48	5.69	5.86
Albumen, insoluble	8.31	8.96	8.75	9.11	7.97	8.77	8.31	9.39
Crude fiber	1.60	1.62	1.88	2.18	1.51	1.54	1.80	1.59
Total nitrogen × 6.25	11.75	13.62	12.94	14.00	13.62	15.25	14.00	15.15

The following history is given of the origin of the various wheats and the treatment to which they have been submitted, and some remarks upon the crossing of the several so-called hybrids in Professor Blount's own words:

Blount's Hybrid No. 10, a cross of the New York Deihl upon Virginia Golden Straw.
Blount's Hybrid No 15, a cross of the Sonora upon Lost Nation.
Blount's Hybrid No. 16, a cross of the Improved Fife upon Russian.
Blount's Hybrid No. 17, a cross of the Odessa upon Sonora.
Blount's Hybrid No. 18, a cross of the Australian Club upon Improved Fife.
Blount's Hybrid No. 19, a cross of the Improved Fife upon Oregon Club.
Blount's Hybrid No. 20, a cross of the Oregon Club upon Sonora.
(The first-named variety in the list is the father, the second the mother.)

These hybrids are but two years old, and hence have not become "fixed." I crossed them in order to make the offspring better in quality and quantity, for both farmer and miller.

The objects attained by crossing wheats, or hybridization, as it is improperly called, are manifold. It improves the plant in various ways. It makes it more vigorous; less liable to the attacks of vegetable parasites; the straw is stiffer, better glazed and more healthy; the leaves better feeders as well as the roots; the glumes are more compact and better filled; the heads longer, and fertilization takes place much more surely and successfully.

Second, it improves the grain; makes it more plump, heavier, harder, consequently better suited to milling purposes; the bran is made thinner, more free from fluff and cellulose—the two obstacles that interfere so materially with milling; the grain is entirely transformed, being made to contain more or less gluten, starch, and other elements that make good flour. The whole operation is very similar to breeding stock.

The experimenter must thoroughly understand the entire vegetable and physiological structure of both wheats before he can make a cross or an improvement on either parent.

An examination of the table of analysis, for instance, will show success and failures in my work. A success cannot always be made the first trial nor the second. The experimenter is compelled to cross and recross again sometimes, in order to make a wheat that will suit both farmer and miller. Take Hybrid No. 18, for instance. It is a failure, so far as being fit for the mill is concerned. Why? Because the per cent. of gluten is very much less than that of its mother (1423—Improved Fife), and but little, very little, higher than that of its father (891—the Australian Club). Had it been 11.57 per cent., or the average of both, or more, there might have been a chance of making it a success. One more trial (the third) will settle the question whether or not it is worthy to be placed among the standards. So far as it is a success or failure for the farmer remains yet to be determined. Many wheats are splendid in the field and are no manner of account in the mill, and *vice versa*.

Please notice No. 19 in the table. The father wheat (Improved Fife) contains 14.23 per cent. of gluten, the mother (Oregon Club) 10.06 per cent.; average, 12.14 per cent.; exactly the per cent. that No. 19 contains. Now, both these parent wheats are good for both farmer and miller, and I have reason to conclude that this offspring will be better than either parent when it becomes "fixed." It is now only two years old and will not become fixed or a standard until next year.

HISTORY.

The Black-Bearded Centennial came originally from New South Wales. It is probably the heaviest wheat known, 74 pounds per struck bushel. It is an enormous feeder and an enormous yielder, 2 ounces producing last year 25 pounds 6 ounces. From the table it cannot be said to be a good milling wheat.

It has the finest head and kernel of any I have ever handled or seen. It took the first premium for being the heaviest in New York last August over two or three thousand competitors—average head weighing 107 grains troy, while the next heaviest weighed 92, making the Black-Bearded Centennial 15 grains troy heavier than any other's average head.

The Eldorado is an improvement on the old Egyptian wheat, otherwise called Pharaoh's wheat, Seven-headed wheat, Mummy wheat, &c. In this county (Larimer) it has produced 90 bushels per acre.

The White Mexican *vs.* White Siberian originally came from Siberia, in Asia. It has held its own more tenaciously than any of the standards. It is whiter and lighter than it was ten years ago, but the table shows it to be the best milling wheat when improved (as I have improved it in the last three years) of all the thirty-two. For the farmer this variety is not profitable to raise, from the fact that the straw is very weak and rusts badly on all the soils where there is the least dampness or too much alluvial matter in the soil.

The Judkin is a Pennsylvania wheat, and comes as one of the best winter varieties. I turned it into a spring wheat three years ago, since which time it has proved to be among the best. It produces a little more grain in weight than straw, and yields over 320 from one. Its color is red, and remarkably uniform. It has a strong, stiff straw, a little too long, and has good milling properties.

While the Australian Club exhibits poor milling properties in the table, it is one of the most prolific and successful varieties for the farmer. It produced 416 from one last year, and has straw, color, and grain that can hardly be excelled. It came from Australia, but is no kin to the hard and soft Australian wheats. It is hard, and has a large amber kernel.

The White Fountain comes to me from Montana. I have raised it but one year. It yields abundantly—404 from one; has a stiff, strong straw; does not rust, and ripens evenly. The table shows its milling properties to be good. I received 101 pounds from four ounces sowing. It is a smooth, white wheat, of great value.

Perfection was received last year from Palestine under a variety of names. Half ounce produced six pounds of grain and seven of straw. The straw is coarse, strong, and stiff; the grain is large, white, and uniform in color. Its milling properties are fair. It does not appear to be subject to rust or smut in this climate. On the whole, it is a good wheat for the farmer and miller.

The Russian came to me from Moscow three years ago. Three years' test makes it one of the best red wheats I have. It has one failing—shelling too easily when cut too ripe. Aside from this fault, it commends itself to every farmer, and especially to the miller. As its flour is of the best, it produced, first year, 76 from one; second year, 172 from one; third year, 448 from one.

Rio Grande is the best of all the bearded varieties I have for milling. Like the Russian, it shells badly, being clad with but a single glume. Sometimes the grain grows without any natural covering at all. I have crossed it upon the Champlain, the effect of which has given every kernel in the offspring its proper amount of clothing, two glumes, two palets, and two lodicules.

The Touzelle was obtained from France. It is the finest looking of all the French bearded wheats. It improves rapidly by selection and cultivation. First year it produced 56 from one; second year it produced 128 from one; third year it produced 480 from one. As will be seen in the table, it is not yet a good milling wheat, from the fact that it is destitute of the proper per cent. of gluten.

The German Fife came from Saxony, and has been tested on these grounds but one year. In all respects, as the table and the experiments made with it here shows, it is unexceptionally one of the best wheats grown anywhere. It is not handsome, but very strong, and a good one for both farmer and miller. It is a bearded, red variety, strong straw, with grain well protected. One ounce produced seven pounds grain and eight of straw—112 fold.

The Oregon Club has been a much better wheat than it now is. Its milling properties have greatly deteriorated by bad selection, or no selection. It is prolific, nevertheless, producing this year 480 from one. There are two evils that attend this wheat; it will rust in damp seasons and low soils, and the heads break off badly in harvesting if permitted to get too ripe. I obtained seed from Oregon.

The Sonora sells readily for seed and flour. Some millers do not like it, and some farmers won't raise it. It is really a good wheat if milled properly and cultivated with some care. I have raised it for three years. The first year it produced 56 from one, the second year it produced 110 from one, the third year it produced 448 from one. It came from Mexico, below the Gulf of California.

The Improved Fife commends itself to every one who has seen and raised it. So far as the farmer's interests are concerned, it will pay him to make use of it. It has for three years exhibited no failing whatever. The table shows it to be of the best milling properties. It is an improvement on the old Saxon Fife. The first year it produced 56 from one, the second year it produced 126 from one, the third year it produced 416 from one on these grounds.

The Lost Nation is an old "stand-by" in the Eastern States. Seed was sent me three years ago from Chester County, Pennsylvania, and the three tests I have given it show it to be an excellent variety for the farmer, and the table shows it to be a pretty fair milling wheat. The first year it produced 76 from one, the second year it produced 96 from one, the third year it produced 352 from one.

Although Pringle's Hybrids Nos. 4 and 6 exhibit fair milling properties in the table, they are not profitable for the farmer on account of one failing—both shell so badly while being harvested that the farmer loses three or four bushels per acre. These came from Vermont.

The Clawson, from Pennsylvania, is so widely known it is hardly necessary to notice anything pertaining to it, except the results that have been obtained on these grounds for three years. It is a winter variety, and almost absolutely refuses to be transformed into a spring wheat. It has done well, and commends itself to the farmer for being very prolific and free from almost all diseases and accidents. The first year it produced 68 from one, the second year it produced 136 from one, the third year it produced 544 from one. The straw is strong, well glazed, and never falls. The heads are remarkably long, and always well filled. It does not "kill out" in the winter, but grows well, and is green all the time, no matter how cold it is.

The Hedge Row White Chaff is properly named. From what source it came I am unable to say. It shows fair milling properties, and so far as being profitable in the field there is no doubt. The straw is coarse, stiff, and rough, and the chaff holds its grain as tenaciously as an old animal does its prey; in fact, it is so hard to thrash that it is an utter impossibility to clean it thoroughly. It is a good variety to cross with a finer wheat that shells easily. Hedge Row Red Chaff is, in all respects, like the other, with the exception of the color of its chaff and grain. White Chaff, so called because its head, when repining, fairly glistens in the sun, has several names. It is a bearded variety and prolific, producing more than 400 from one Triticum. I received from Samara, on the Volga River, last year. It was the poorest looking wheat I had ever seen. The table shows it to be above medium for the mill, and one season here proves it to be excelled by but few. It produced as much grain as straw, and yielded 192 fold.

The Durum and Doty came from Saratov, Russia, last year. One test proved but little as to their merits.

The Meekins came from St. Petersburgh, and commends itself to the farmer and miller.

My No. 10, a cross of the New York Deihl upon the Virginia Golden Straw, now three years old, is "fixed" and so far claims the attention of all who see the grain or straw. Its milling properities, as seen in the table, speak for themselves. It has a stiff, strong straw, has not rusted at all, and the head is one of the finest and largest known. Over 100 grains are found in a large proportion of them. The wheat came from but one kernel planted in 1880. The one kernel produced the first year five good heads, containing in all 474 kernels. These I planted again in 1881, and I have now thirty pounds or more, which will produce at least 50 to 100 bushels by careful sowing and cultivation.

All these remarks and statistics are made with reference to this climate and locality. They may or may not apply to other sections and other States. All these wheats have been improved by selection and crossing, cultivation and irrigation, under different treatment. In this as well as in different soils and climates they might do better or they might do worse.

I am convinced that wheats that are made on the ground where they are to be raised will do much better in every respect than such as may be imported.

Professor Blount's description of his attempts and their results shows how much there is to be done in this country in the improvement of seed by selection and fixing of new varieties. There is no variety in the list analyzed which was not easily improved in yield, and probably also in quality, by selection and careful cultivation for a few years. That the quality of Professor Blount's wheats is above that of ordinary wheats is shown in the following table of averages:

Average composition of wheats of North America.

	Winter.			Spring.
	32 wheats from Blount, of Colorado.	10 seed wheats, Department of Agriculture.	40 wheats averaged by Armsby.	5 seed wheats, Department of Agriculture.
Water	9.85	8.70	10.93	8.58
Ash	2.29	1.67	1.70	1.73
Oil	2.42	2.22		2.40
Starch	70.46	74.97	75.66	73.27
Fiber	1.58	1.49		1.76
Albumen	13.40	10.95	11.71	12.31
Highest albumen	15.94	13.82	14.47	16.89
Lowest albumen	11.19	9.28	8.40	8.83

Although the number of analyses of wheat made in this country is very small, they will serve to show the immense opportunity which we have for improvement.

Wolff gives the following as the average composition of German wheat:

Water	14.4
Ash	1.7
Fat	1.5
N, free substance	66.4
Crude fiber	3.0
Crude albumen	13.0

It agrees with the composition of Professor Blount's wheat as far as the most valuable constituent, albumen, is concerned, but beyond that the Colorado wheat is superior, having more fat and less fiber, very much as we have seen to be the relations of the German and American grasses. The lower amount of water in our wheats is probably to be explained by more thorough desiccation of the small samples which have been analyzed.

As it has become the custom to judge from the amount of gluten in a wheat as to its value and milling properties, it is advantageous to consider what this determination represents.

The nitrogenous constituents of the wheat, not including the outer husk, which does not appear in flour, are four in number, possessing different solubilities, by means of which they may be separated. What is done in determining the amount of gluten in a wheat is to wash away all the husk or bran and starch by means of water, as well as that portion of the nitrogenous constituents which is soluble in water. What is left is called *gluten*, and consists, in addition to certain impurities which escaped washing away, of the four principal nitrogenous substances in the wheat. They are called by *Ritthausen*, *Gliadin*, *Gluten-casein*, *Gluten-Fibrin*, and *Mucedin*. Their relative proportion varies in different wheats, and it is upon this as well as upon the amount of gluten that the properties of the wheat depend.

As the greater portion of the albumenoid substances are contained in the gluten, the amount of the latter must be dependent on the amount of nitrogen in the wheat. This determination is one that is easily made in the laboratory, so it is of importance to see what the average relation of nitrogen to gluten is.

The determinations which we have made with Mr. Blount's wheats are tabulated below in the order of their nitrogen content, and it is evident that in a general way the amount of gluten is proportional to the amount of nitrogen.

Book number.	Total nitrogen.	Dry gluten.	Moist gluten.		Dry-moist gluten.	Dry gluten to nitrogen.
744	1.88	9.99	26.91	S.	37.1	5.31
721	1.88	11.19	32.92	S.	34.0	6.48
728	1.88	9.49	25.06	H.	37.8	5.05
731	1.79	8.91	25.23	S.	35.3	4.97
727	1.93	9.22	23.80	(?)	38.7	4.77
720	1.96	11.38	32.24	S.	35.3	5.81
725	1.96	11.74	35.22	(?)	33.3	6.00
730	1.96	12.10	33.59	(?)	36.0	6.17
738	1.96	10.06	28.92	S.	34.8	5.13
724	1.99	12.14	36.96	(?)	32.8	6.10
726	2.02	10.64	28.31	H.	37.6	5.26
723	2.07	10.74	32.22	(?)	33.3	5.19
741	2.07	11.23	29.52	S.	38.0	5.41
746	2.07	10.69	30.14	H.	35.5	5.16
742	2.16	11.83	34.78	M.	34.0	5.63
736	2.16	10.90	33.05	H.	33.9	5.04
722	2.18	11.88	34.16	H.	34.8	5.45
732	2.18	11.93	35.15	H.	33.9	5.47
745	2.18	12.11	34.01	M.	35.6	5.55
748	2.18	13.08	34.32	H.	38.1	6.00
729	2.21	14.33	42.12	(?)	34.0	6.49
747	2.24	11.37	32.24	S.	35.3	5.08
750	2.24	12.52	35.81	S.	34.9	5.58
733	2.27	12.07	35.36	H.	34.1	5.31
739	2.27	11.83	34.86	S.	33.9	5.19
734	2.32	12.13	32.41	S.	37.4	5.23
735	2.35	12.34	35.01	S.	35.2	5.25
737	2.41	14.45	38.33	S.	37.7	6.00
743	2.44	12.06	33.69	H.	35.8	4.94
749	2.44	13.51	37.54	H.	35.9	5.54
751	2.44	13.83	36.61	S.	37.8	5.66
740	2.55	14.23	39.47	H.	36.0	5.58
Average	2.14	11.74	33.12		35.5	5.49

From an average of all, it appears that the dry gluten is 5.49 times the nitrogen, with extremes of 6.49 and 4.77, and the average amount of dry gluten 11.74 per cent. Ritthausen found from the examination of thirty-eight wheats that the gluten was 5.64 times the nitrogen, and the average content of gluten was 14.38 per cent. These, however, included many spring wheats, which are much higher in gluten than winter varieties.

The name *gluten* has been the cause of great confusion in the English language, having been applied to that portion of the nitrogenous substances in the wheat extracted, as has already been described; and, again, when spelled *glutin*, to that portion of the gluten which we have called after Ritthausen *Gliadin*. It will be well, then, to remember that gluten corresponds to the German *Kleber*, and consists of four distinct substances, while the name glutin is better replaced by *Gliadin*. Another very serious error has arisen, and had a large circulation of late, in the opinion that all the gluten of the wheat is in the husk, and that the modern methods of milling were preparing a flour more and more poor in this substance. This report has even been published in a medical journal. Every miller probably understands that the modern improvements, instead of diminishing the amount of gluten, would, if anything, tend to increase it, or certainly to furnish a more valuable flour. From the previous explanation and discussion of the matter this must be plain to all.

CORN AND SORGHUM AS FODDER PLANTS.

The attention which, during the last few years, has been given to the ensilage of corn and sorghum, and the large amount of discussion which has taken place as to which was preferable, dried corn fodder or that which has been packed in silos, seem to make a thorough investigation of the subject both from a theoretical and practical point of view necessary.

Among the questions which arise in either method of preserving corn and sorghum for feeding is, What is the proper time for cutting, and which crop is the best as far as composition is concerned? The following analyses have been made as a contribution to our knowledge of the subject:

TABLE XIII.—*Egyptian Sugar Corn, planted April* 30, 1881.

STALKS.

	503. June 13.	509. June 20.	517. June 27.	526. July 5.*	540. July 11.†	547. July 11.‡	568. July 18.
DEVELOPMENT.							
Height	2.5	2.8	4.5	7.0	7.2	8.5	9.0
Diameter	.8	1.1	1.0	1.2	1.2	1.1	1.2
Total weight	126.2	349	656	1243	1097	1037	1378
Weight of stalk	69.8	219	438	960	585	542	618
Weight of leaves	56.4	130	218	216	468	430	651
Weight of top	......	......	......	66	44	35	26
Weight of ear	......	......	......	......	......	......	83
Per cent. of stalk in whole plant	55.3	6.28	6.68	77.3	53.3	52.1	44.9
DRY SUBSTANCE.							
Ash	17.53	13.34	9.74	9.72	9.09	6.53	5.60
Crude fat	3.51	4.00	3.02	2.58	1.80	1.68	3.44
N. free extract	32.50	44.73	55.43	50.60	51.20	52.41	60.45
Crude fiber	21.42	20.57	22.74	27.01	26.38	31.29	26.04
Crude albumen	25.04	17.36	9.07	10.09	11.53	8.09	4.43
Total nitrogen	4.01	2.78	1.45	1.61	1.85	1.29	.71
Non-albuminoid N	2.51	1.70	.75	.99	1.27	.85	.31
Per cent. of N. as non-albuminoid	62.6	61.1	51.7	61.4	68.6	65.9	43.7
ORIGINAL SUBSTANCE.							
Water	94.20	94.10	92.60	91.60	91.30	88.30	85.90
Ash	1.02	.79	.72	.82	.79	.76	.79
Crude fat	.20	.24	.22	.21	.16	.19	.49
N. free extract	1.88	2.64	4.11	4.25	4.45	6.14	8.53
Crude fiber	1.25	1.11	1.68	2.27	2.30	3.66	3.67
Crude albumen	1.45	1.02	.67	.85	1.00	.95	.62

* Top just out. † Anthers not out. ‡ Anthers out, filling

TABLE XIII.—*Egyptian Sugar Corn planted April* 30, 1881—Continued.

STALKS.

	576. July 25.*	580. August 1.†	594. August 8.	617. August 15.	625. August 22.	636. August 29.	640. September 5.
DEVELOPMENT.							
Height	9.2	10.2	10.0	9.5	9.5	8.2	9.2
Diameter	1.2	1.6	1.2	.9	1.1	1.2	1.1
Total weight	1642	1722	1068	712	820	1000	614
Weight of stalk	575	636	593	309	371	595	347
Weight of leaves	737	864	300	....	....	....	....
Weight of top	78	82	9	....	....	....	....
Weight of ear	252	190	166	....	....	....	....
Per cent. of stalks in plant	35.0	37.0	55.5	43.4	45.2	59.5	56.5
DRY SUBSTANCE.							
Ash	4.81	5.87	4.97	3.54	6.94	6.00	4.17
Crude fat	2.75	2.35	2.10	2.21	1.81	3.75	1.64
N. free extract	61.53	66.72	67.37	64.13	56.29	64.71	59.18
Crude fiber	26.06	22.07	21.82	24.41	32.64	18.71	32.13
Crude albumen	4.85	2.99	3.74	5.71	2.32	6.83	2.88
Total nitrogen	.78	.48	.60	.91	.37	1.09	.46
Non albuminoid N	.39	.29	.33	.58	.13	.55	.22
Per cent. of N. as non-albuminoid	50.0	60.5	55.0	63.7	35.1	50.5	47.8
ORIGINAL SUBSTANCE.							
Water	83.20	80.20	80.60	79.20	79.70	76.70	74.80
Ash	.81	1.16	.96	.74	1.41	1.40	1.05
Crude fat	.46	.47	.41	.46	.37	.87	.41
N. free extract	10.34	13.21	13.07	13.33	11.42	15.08	14.91
Crude fiber	4.38	4.37	4.23	5.08	6.63	4.36	8.10
Crude albumen	.81	.59	.73	1.19	.47	1.59	.73

* Silk out. † Ear formed.

TABLE XIII.—*Egyptian Sugar Corn, planted April* 30, 1881—Continued.

LEAVES.

	504. June 13.	510. June 20.	518. June 27.	527. July 5.	541. July 11.	548. July 11.	563. July 18.	577. July 25.	591. August 1.	605. August 8.
DEVELOPMENT.										
Per cent. of leaves in plant	44.7	37.2	33.2	17.4	42.7	41.4	47.2	44.9	50.0	28.1
DRY SUBSTANCE.										
Ash	11.25	10.16	8.70	8.67	10.12	10.22	8.83	7.60	11.36	8.71
Crude fat	4.59	4.00	3.51	3.64	3.44	4.04	3.58	4.02	4.15	3.08
N. free extract	32.56	40.60	45.81	46.96	46.25	45.48	52.69	56.95	55.44	58.29
Crude fiber	28.34	24.11	25.86	24.94	25.15	25.79	24.51	21.96	20.48	24.08
Crude albumen	23.26	19.13	16.12	15.79	15.04	13.57	10.39	8.87	8.57	5.84
Total nitrogen	3.72	3.06	2.58	2.53	2.41	2.17	1.66	1.42	1.37	.93
Non-albuminoid N	1.69	1.14	1.08	.99	1.09	1.00	.65	.30	.58	.25
Per cent. of N. as non-albuminoid	45.4	37.3	41.8	39.1	45.2	46.1	39.2	21.1	42.3	26.9
ORIGINAL SUBSTANCE.										
Water	88.20	86.70	84.80	89.40	86.60	85.20	84.20	82.30	61.10	64.50
Ash	1.33	1.35	1.22	.92	1.36	1.51	1.40	1.35	4.42	3.09
Crude fat	.54	.53	.53	.39	.46	.73	.57	.82	1.61	1.09
N. free extract	3.81	5.67	6.97	4.98	6.20	6.73	8.32	10.08	21.57	20.70
Crude fiber	3.35	3.21	3.93	2.64	3.37	3.82	3.87	3.88	7.97	8.55
Crude albumen	2.74	2.54	2.45	1.67	2.01	2.01	1.64	1.57	3.33	2.07

TABLE XIII.—*Egyptian Sugar Corn, planted April 30, 1881*—Continued.

TOPS.

	528. July 5.	542. July 11.	549. July 11.	564. July 18.	578. July 25.	592. August 1.	606. August 8.
DEVELOPMENT.							
Per cent. of tops in plant	5.3	4.0	6.5	1.9	4.8	1.8	.9
DRY SUBSTANCE.							
Ash	5.01	4.03	4.99	5.81	5.48	7.02	5.42
Crude fat	4.41	3.80	5.80	3.59	2.77	3.74	2.82
N. free extract	46.53	51.93	51.00	53.16	59.61	55.07	56.34
Crude fiber	26.96	23.37	19.73	27.33	25.23	26.47	31.29
Crude albumen	17.09	15.97	18.48	10.11	6.91	7.70	4.73
Total nitrogen	2.73	2.55	2.96	1.62	1.11	1.23	.76
Non-albuminoid N	1.18	.62	1.08	.48	.24	.30	.06
Per cent. of N. as non-albuminoid	43.2	24.3	36.5	29.6	21.6	24.2	7.9
ORIGINAL SUBSTANCE.							
Water	77.70	77.50	57.40	58.40	62.40	57.50	26.90
Ash	1.12	1.11	2.13	2.42	2.06	2.98	3.96
Crude fat	.98	.86	2.47	1.49	1.04	1.59	1.62
N. free extract	10.38	11.68	21.72	22.11	22.41	23.41	41.19
Crude fiber	6.01	5.26	8.41	11.37	9.49	11.25	22.87
Crude albumen	3.81	3.59	7.87	4.21	2.60	3.27	3.46

TABLE XIV.—*Lindsay's Horse Tooth Corn, planted April 30, 1881.*

STALKS.

	505. June 13.	511. June 20.	519. June 27.	529. July 5.	544. July 11.	558. July 18.
DEVELOPMENT.						
Height	2.8	3.2	5.8	6.0	8.8	10.8
Diameter	1.0	1.2	1.3	1.0	1.5	1.2
Total weight	250	442	1076	1238	1598	1402
Weight of stalk	154	308	801	877	928	768
Weight of leaves	96	134	275	361	617	652
Weight of top	....	....	....	....	53	30
Weight of ear	....	....	....	....	....	52
Per cent. of stalk in plant	61.6	79.7	72.6	70.9	58.1	54.8
DRY SUBSTANCE.						
Ash	18.00	14.48	11.06	8.03	8.01	5.31
Crude fat	3.25	2.09	2.39	2.31	2.91	1.99
N. free extract	35.63	48.31	53.30	61.19	58.29	64.55
Crude fiber	20.40	20.50	21.83	24.25	27.97	23.01
Crude albumen	22.72	14.02	10.82	4.22	7.82	3.14
Total nitrogen	3.63	2.24	1.73	.67	1.25	.50
Non-albuminoid N	2.27	1.24	1.15	.29	.88	.09
Per cent. of N. as non albuminoid	62.5	55.4	65.9	43.3	70.4	18.0
ORIGINAL SUBSTANCE.						
Water	94.10	94.20	93.80	89.00	90.50	85.60
Ash	1.06	.84	.72	.84	.76	.78
Crude fat	.19	.16	.15	.24	.28	.29
N. free extract	2.10	2.80	3.31	6.36	5.06	9.29
Crude fiber	1.21	1.19	1.35	2.82	2.66	3.09
Crude albumen	1.34	.81	.67	.44	.74	.45

TABLE XIV.—*Lindsay's Horse Tooth Corn, planted April* 30, 1881—Continued.

STALKS.

	579. July 25.	608. August 8.	618. August 15.	626. August 22.	637. August 29.	641. Septemb'r 5.
DEVELOPMENT.						
Height	11.3	9.0	11.0	10.7	10.3	10.8
Diameter	1.1	1.4	1.2	1.4	1.1	1.2
Total weight	1375	1875	1174	2046	1252	865
Weight of stalk	730	854	559	1133	694	450
Weight of leaves	522	673	603	388	....	....
Weight of top	95	10	12	....	....	....
Weight of ear	28	338	....	....	....	....
Per cent. of stalk in plant	53.1	45.5	47.6	56.3	55.4	52.0
DRY SUBSTANCE.						
Ash	5.07	4.34	5.19	5.12	3.61	5.08
Crude fat	2.55	2.81	2.18	2.44	3.24	1.68
N. free extract	60.70	66.66	69.40	63.12	69.54	59.60
Crude fiber	27.99	22.82	21.56	23.41	21.99	32.32
Crude albumen	3.69	3.37	1.67	5.91	1.62	1.32
Total nitrogen	.58	.54	.27	.95	.26	.21
Non-albuminoid N	.21	.27	.05	.65	.15	.13
Per cent. of N. as non albuminoid	36.2	50.0	18.5	68.4	57.7	61.9
ORIGINAL SUBSTANCE.						
Water	83.20	80.80	79.10	80.00	78.60	73.60
Ash	.85	.83	1.08	1.02	.77	1.34
Crude fat	.43	.54	.45	.49	.69	.44
N. free extract	10.20	12.80	14.51	12.63	14.88	15.74
Crude fiber	4.70	4.38	4.51	4.68	4.71	8.53
Crude albumen	.62	.65	.35	1.18	.35	.35

LEAVES.

	506. June 13.	512. June 20.	520. June 27.	530. July 5.	545. July 11.	567. July 18.	580. July 25.	595. August 1.	609. August 8.	627. August 22.
DEVELOPMENT.										
Per cent. of leaves in plant	38.4	20.3	27.4	19.1	38.6	39.4	37.8	37.8	35.9	44.7
DRY SUBSTANCE.										
Ash	11.62	10.13	10.55	9.98	9.59	9.04	8.63	9.42	6.92	11.14
Crude fat	4.91	3.90	3.97	3.71	2.99	3.37	3.85	3.48	3.38	2.96
N. free extract	45.04	46.50	44.97	50.40	49.37	54.79	56.35	56.96	61.72	57.06
Crude fiber	13.25	20.62	23.70	22.91	24.22	23.40	20.39	18.24	20.41	21.20
Crude albumen	25.18	18.85	16.81	13.00	13.88	9.40	10.78	11.90	7.57	7.64
Total nitrogen	4.03	3.02	2.69	2.08	2.21	1.50	1.73	1.90	1.21	1.22
Non-albuminoid N	1.49	.99	.98	.77	1.03	.50	.47	.66	.24	.46
Per cent of N. as non albuminoid	37.0	32.8	36.4	37.0	46.6	33.3	27.2	34.7	19.8	37.7
ORIGINAL SUBSTANCE.										
Water	85.80	85.40	84.40	80.80	84.20	80.90	80.20	81.50	83.00	63.70
Ash	1.65	1.48	1.65	1.91	1.51	1.73	1.71	1.74	1.18	4.04
Crude fat	.70	.57	.62	.71	.47	.64	.76	.64	.57	1.08
N. free extract	6.39	6.79	7.01	9.68	7.80	10.46	11.16	10.54	10.49	20.71
Crude fiber	1.88	3.01	3.70	4.40	3.83	4.47	4.04	3.37	3.47	7.70
Crude albumen	3.58	2.75	2.62	2.50	2.19	1.80	2.13	2.21	1.29	2.77

TABLE XIV.—*Lindsay's Horse Tooth Corn, planted April* 30, 1881—Continued.

TOPS.

	546. July 11.	563. July 18.	581. July 25.	596. August 1.
DEVELOPMENT.				
Per cent. of tops in plant	3.3	2.1	7.0	.5
DRY SUBSTANCE.				
Ash	5.08	5.04	5.29	5.50
Crude fat	3.97	3.68	3.20	3.[illegible]
N. free extract	50.99	61.63	59.99	56.21
Crude fiber	21.41	19.56	23.71	24.48
Crude albumen	18.55	10.09	7.81	8.73
Total nitrogen	2.97	1.61	1.25	1.40
Non-albuminoid N	1.24	.32	.36	.42
Per cent. of N. as non-albuminoid	41.7	29.9	28.8	30.0
ORIGINAL SUBSTANCE.				
Water	74.50	62.40	44.40	44.40
Ash	1.30	1.90	2.94	3.46
Crude fat	1.01	1.38	1.78	1.71
N. free extract	13.00	23.17	33.36	32.37
Crude fiber	5.46	7.36	13.18	12.61
Crude albumen	4.73	3.79	4.34	4.85

TABLE XV.—*Early Amber Sorghum, planted May* 1, 1881.

STALKS.

	515. June 27.	521. July 5.	550. July 14.*	556. July 18.	584. August 1.	598. August 8.†	611. August 15.	619. August 22.	628. August 29.
DEVELOPMENT.									
Height	2.8	3.7	6.0	7.7	8.5	9.2	8.9	8.5	8.8
Diameter	.7	.7	.7	.8	.6	.7	.6	.6	.7
Total weight	127	225	362	467	506	515	461	389	497
Weight of stalks	100	168	233	325	368	375	328	259	343
Weight of leaves	27	57	108	116	114	125	100	70	85
Weight of tops	......	......	21	26	24	15	......	......	......
Weight of suckers	......	......	......	......	......	......	33	60	69
Per cent. of stalks in plant	78.7	74.7	64.4	70.0	72.7	72.8	71.1	66.6	68.0
DRY SUBSTANCE.									
Ash	14.64	12.22	7.39	5.71	4.20	3.07	2.64	6.20	2.66
Crude fat	2.86	5.31	3.61	5.40	5.14	6.02	4.43	3.74	3.95
N. free extract	27.70	50.59	56.09	54.20	67.24	69.69	72.40	68.86	75.15
Crude fiber	37.10	18.19	25.62	28.85	19.72	17.67	17.20	17.75	15.18
Crude albumen	17.70	13.70	7.27	5.84	3.70	3.55	3.33	3.45	[illegible]
Total nitrogen	2.83	2.19	1.16	.93	.59	.57	.53	.55	.49
Non-albuminoid N	1.85	1.35	.72	.48	.36	.24	.22	.28	.19
Per cent. of N. as non-alb.	65.4	61.6	61.7	51.6	61.0	41.5	41.7	50.0	37.8
ORIGINAL SUBSTANCE.									
Water	93.20	91.50	88.80	86.40	73.30	72.60	68.80	67.30	65.10
Ash	1.00	1.07	.83	.78	1.12	.84	.82	2.03	.92
Crude fat	.20	.45	.41	.74	1.37	1.65	1.38	1.22	1.47
N. free extract	1.87	4.30	6.28	7.37	17.95	19.10	22.59	22.53	26.22
Crude fiber	2.53	1.55	2.87	3.91	5.27	4.84	5.37	5.80	5.39
Crude albumen	1.20	1.33	.80	.80	.99	.97	1.04	1.13	1.07

* Top just out. † Seed in milk.

TABLE XV.—*Early Amber Sorghum, planted May* 1, 1881—Continued.

LEAVES.

	516. June 27.	522. July 5.	531. July 14.	557. July 18.	571. July 25.	585. August 1.	599. August 8.	612. August 15.	620. August 22.
DEVELOPMENT.									
Per cent. of leaves in plant.	21.8	25.8	29.8	24.8	22.5	21.6	21.8	18.0	17.1
DRY SUBSTANCE.									
Ash	10.86	8.85	9.47	9.50	10.00	8.62	9.40	8.77	9.01
Crude fat	5.63	5.36	6.37	4.27	5.35	4.59	4.57	6.62	6.80
N. free extract	36.61	43.43	45.44	49.80	49.83	52.48	52.47	51.64	52.91
Crude fiber	24.02	24.03	25.59	23.90	22.47	22.34	22.74	22.74	21.54
Crude albumen	22.88	18.38	13.13	12.53	12.35	11.61	10.82	10.23	9.74
Total nitrogen	3.66	2.93	2.10	2.00	1.98	1.86	1.73	1.60	1.56
Non-albuminoid N	1.53	1.17	.51	.55	.46	.34	.30	.39	.24
Per cent. of N. as non-albuminoid	41.8	39.9	24.3	27.5	23.2	18.3	17.4	24.4	15.4
ORIGINAL SUBSTANCE.									
Water	81.60	80.80	81.30	83.70	71.20	75.00	76.00	74.30	70.90
Ash	2.00	1.70	1.77	1.55	2.28	2.11	2.26	2.25	2.62
Crude fat	1.04	1.03	1.19	.70	1.22	1.12	1.10	1.70	1.98
N. free extract	6.74	8.34	8.50	8.12	11.36	12.89	12.59	13.27	15.40
Crude fiber	4.42	4.61	4.79	3.89	5.12	5.45	5.46	5.85	6.27
Crude albumen	4.20	3.52	2.45	2.04	2.82	2.83	2.50	2.63	2.83

TOPS.

	532. July 14.	538. July 18.	572. July 25.	586. August 1.	600. August 8.
DEVELOPMENT.					
Per cent. of tops in plant	5.8	5.2	4.8	6.9	5.4
DRY SUBSTANCE.					
Ash	3.79	11.17	6.56	11.38	6.40
Crude fat	2.94	2.28	3.00	3.21	2.84
N. free extract	54.04	47.82	52.74	51.74	55.44
Crude fiber	29.43	28.73	26.12	18.86	26.72
Crude albumen	9.80	10.00	10.95	11.81	8.60
Total nitrogen	1.57	1.60	1.76	1.89	1.38
Non-albuminoid N	.49	.57	.61	.49	.31
Per cent. N. as non-albuminoid	31.2	35.6	34.7	25.9	22.5
ORIGINAL SUBSTANCE.					
Water	74.50	69.20	63.00	60.80	59.30
Ash	.97	2.32	2.43	4.46	2.60
Crude fat	.75	.47	1.33	1.26	1.16
N. free extract	13.78	9.95	19.52	21.45	22.56
Crude fiber	7.50	5.98	9.66	7.39	10.88
Crude albumen	2.50	2.08	4.06	4.64	3.50

TABLE XV.—*Early Amber Sorghum, planted May 1, 1881*—Continued.

SUCKERS.

	615. August 15.	621. August 22.	630. August 29.
DEVELOPMENT.			
Per cent. of each part	7.2	15.4	15.9
DRY SUBSTANCE.			
Ash	7.43	6.85	3.65
Crude fat	4.66	3.84	4.62
N. free extract	55.00	59.60	61.13
Crude fiber	24.63	22.55	22.7[illegible]
Crude albumen	8.28	7.46	7.6[illegible]
Total nitrogen	1.32	1.19	1.2[illegible]
Non-albuminoid N	.49	.36	.46
Per cent. of N. as non-albuminoid	37.1	30.2	37.6
ORIGINAL SUBSTANCE.			
Water	74.20	70.90	68.[illegible]
Ash	1.92	1.99	1.[illegible]
Crude fat	1.22	1.12	1.44
N. free extract	14.18	17.34	19.01
Crude fiber	6.34	6.48	7.0[illegible]
Crude albumen	2.14	2.17	2.[illegible]

The varieties examined were all grown on the grounds of the Department. The specimens were collected and dried every seven days, stalks being selected which seemed to represent the average development of the plat. To obtain an average specimen of such a large plant is, however, much more difficult than in the case of the grasses, where many may be collected and an average taken. In consequence of this, the series does not present that unbroken sequence which appeared in our analyses of the grasses in the last report. For example, sample 626, Lindsay's Horse Tooth Corn, cut August 22, contains an amount of nitrogen far ahead of that in the stalks collected the week before and the week after, not, however, varying much in other respects. It will be seen that this is the heaviest cane which was cut, and the fine growth and development may have been a reason for its increased content of nitrogen. That it is an unusual state of affairs is indicated by the fact that of the total percentage of nitrogen more than half is in a non-albuminoid form.

The non-albuminoid nitrogen in corn and sorghum appears from the tables to be higher than was found to be the case in the grasses, and at the same time there are great variations from week to week in an irregular way. This is more especially the case with the corns, and such irregularities are not surprising after a consideration of the very similar ones which were developed during our investigations of the amount of sugar in the juice of several varieties. How far the results given in the tables may have been changed, or to a certain extent invalidated by the difficulties that are met with in drying such large stalks as those of corn and sorghum which contain much sugar, must remain an open question. The stalks were cut, split in small pieces, and dried in the sun as rapidly as possible, but we are aware from our investigations of the fermentations of the juice of corn and sorghum how liable these plants are to changes brought about in such a way.

The sorghum appears to be much more regular in its composition than the corn, as we should expect from our previous examination of these plants. It contains, too, much less water in its fresh state, and more nitrogen and fat. It appears, in fact, the question of growth and cultivation aside, to be superior to corn for feeding purposes or ensilage.

In both corn and sorghum the leaves contain much more nitrogen than the stem, and consequently should be most carefully preserved in any system of curing, for, at its best, such a fodder is very deficient in nitrogen, and this deficiency, which must be made up in feeding by nitrogenous substances, is only increased by the loss of the leaves.

In the sorghum, it is of interest to see that the suckers, like all parts of new growth, are much richer in nitrogen than the older parts; but at the same time, which is rather unexpected, the amount of fiber is rather increased. In this very constituent, fiber, the sorghum plant presents an anomaly which we have not observed elsewhere. The fiber in the stalk is greatest in amount in the young plant, and decreases with the growth of the stem. In the leaves the change is very small, the older leaves having a trifle less of fiber.

The usual decrease of water in the fresh plant with increase in size is, of course, very apparent.

A further examination of the tops of the sorghum was rendered impossible by the fact that the seed heads were completely destroyed by sparrows as soon as the seed began to harden. Analyses of the seed will be found in another part of this report, from samples collected from other localities.

It was intended to analyze the ears of corn at different periods of development; but, unfortunately, all the specimens were attacked by maggots and spoiled, so that this work must be deferred till another collection can be made.

As to the proper time for cutting corn and sorghum for curing or packing in silos, our analyses would seem to point, in the case of sorghum, to that period in its growth just before the leaves show signs of withering. It is then that the sugar is nearly at its maximum, the nitrogen is in good condition, the leaves being fresh, and the fiber on the decrease. Corn, apparently, for very much the same reasons, is in its best condition about the time of tasseling. The irregularities in the composition of corn at any one period prevent anything more than the most general conclusions, from a chemical stand-point.

ENSILAGE.

Although the facilities of the Department prevent any elaborate investigations into the value of ensilage, beyond a mere chemical examination, the question has attracted so much attention that we have collected and tabulated in this place, together with two analyses made at the Department and one at the New Jersey experiment station, averages of the composition of nine specimens of ensilage from various parts of the country, given in Bulletin No. XI of the New Jersey station, and a general average of all the analyses which have been found in the recent literature of the subject in this country.

In addition, for comparison, are given analyses of a field and sugar corn grown at the Department, and an analysis by Dr. C. A. Goessmann, of the Massachusetts Agricultural College, of a field corn grown by Dr. Bailey, in Massachusetts.

TABLE XVI.—*Analyses of ensilage and corn.*

Constituents.	C. H. Roberts, Poughkeepsie, N. Y.	R. F. Roberts, Alexandria, Va.	New Jersey experimental station, Bulletin XI.	Average of nine analyses, Bulletin XI, New Jersey experimental station.	Average of fourteen general analyses.	Highest determination.	Lowest determination.	Lindsay's Horse Tooth Corn in silk, Department of Agriculture.	Egyptian Sugar Corn in silk, Department of Agriculture.	American Maize, Goessmann.
Water	74.10	77.30	74.50	82.07	80.52	84.87	74.10	83.18	81.55	85.04
Ash	1.48	2.01	1.95	1.16	1.33	2.01	.81	1.17	1.16	.82
Fat	1.74	1.80	.77	.61	.77	1.80	.34	.46	.67	.26
N. free extract	12.87	11.24	13.47	9.37	10.02	13.47	7.03	10.08	10.88	8.49
Fiber	7.04	5.71	7.86	5.69	5.09	7.86	4.68	4.03	4.44	4.53
Albumen (N. × 6.25)	2.77	1.94	1.75	1.10	1.37	2.77	.88	1.08	1.30	.86

Ensilage, then, is a fodder which presents large variations in composition, plainly dependent on three causes, the original composition of the corn, which is itself very changeable for different varieties, soils, and period of harvesting, the amount of water lost by evaporation, and the amount of fermentation it undergoes. The first analysis in the table shows a remarkably large amount of albumen, and it is owing in this case to a relative increase from a large loss of carbo-hydrates by fermentation. The next two analyses are in a like way higher than usual in nitrogenous constituents. It will be noticed that this is a relative gain from the increase in the amount of ash and diminution of water in all these specimens. This point should guard us from too hastily assigning an increased value to ensilage, judging from its relative percentage composition. This is well shown in the following:

At the New Jersey College Farm an experiment was undertaken on September 1, 1881, when the corn was in the milk, and in flourishing condition, to determine whether the loss of nutrients is greater when green corn fodder is dried in stacks or preserved in silos, and whether ensilage is preferable to dried fodder corn for the production of milk.

Ten tons of green fodder corn was employed, half of it being stacked in the field in fifty small portions, and the remainder, after being cut in lengths of three-sixteenths of an inch, closely packed in a silo of twelve tons capacity. A sample was carefully selected from the green substance, and its analysis represents the average composition of the lot.

In November, after an exposure to the weather of nearly three months, twelve hundred pounds were passed through a cutter, and a sample analyzed, showing the changes which the corn had undergone in this treatment.

On the 23d of December, the contents of the silo having been found to be in good condition, a sample was taken 18 inches from the surface, an analysis of which represents the changes which had taken place in the formation of the ensilage. The sample was free from disagreeable smell, insipid to the taste, and in all respects equal to the best ensilage seen at the experiment station.

The composition of the three samples may be compared in the following table:

	Green stalks.	Dried stalks.	Ensilage.
Water	75.00	39.37	74.50
Ash	1.58	4.63	1.95
Fat	.22	.66	.77
N. free extract	15.60	32.85	13.47
Crude fiber	6.35	18.65	7.86
Crude albumen	1.25	3.84	1.75
DRY SUBSTANCE.			
Ash	6.32	7.64	7.71
Fat	.88	1.09	1.06
N. free extract	62.40	54.18	53.24
Crude fiber	25.40	30.76	31.07
Crude albumen	5.00	6.33	6.92

The ash, of course, will not be affected by any fermentative changes, so it furnishes a basis on which to calculate those changes which have taken place in the organic constituents.

One hundred pounds of the dry matter of the green corn contains 6.32 pounds of ash. The question then arises, How many pounds of the dry matter of the cured corn and ensilage contain the same amount of ash? And this is as follows:

	Green stalks.	Dry stalks.	Ensilage.
Ash	6.32	6.32	6.32
Fat	.88	.90	.86
N. free extract	62.40	44.82	43.64
Crude fiber	25.40	25.44	25.49
Crude albumen	5.00	5.24	5.67
Total weight dry matter to 6.32 pounds ash	100.00	82.72	81.98

It is plain that the total loss falls upon the carbo-hydrates, and that the loss in field-curing is no greater than in the system of ensilage. Admitting, however, this last fact, the question arises: Will cows eat the dry fodder as readily and with as little waste as the ensilage, and how does the quantity and quality of milk compare with each? The conclusions reached in this regard were:

When dried corn fodder is cut and crushed it is eaten as readily and with as little waste as ensilage. That with four cows in three cases where ensilage was substituted for dried corn in the ration no increase of milk was apparent, while in the fourth there was an increase of eighty-seven pounds of milk in forty days. That in the mixed milk of one herd ensilage caused no increase in solid matter, while in another herd for the same period there was a gain of 8⅓ pounds, or 7 per cent. It still remains an open question whether ensilage possesses such an advantage over dried corn fodder as has been claimed for it, and the question in fact seems to be reduced to one of economy in the preservation and preparation of the corn and of palatability to the cattle. Before, however, a conclusion can be reached, further experiments similar to those detailed must be carried out.

The acidity and alcoholic nature of the ensilage has been of universal remark, and, to a certain extent, of exaggeration. With a view of throwing some light upon this subject the juices expressed from the two samples mentioned in the previous table have been examined. In both cases alcohol was found, but not in amount sufficient to be determined. In the sample from C. H. Roberts, of Poughkeepsie, N.Y., the conditions had been such as to make the alcoholic fermentation most prominent, but even under these circumstances alcohol was only recognized in the distillate from the juice by the iodoform test. The juice expressed from the specimen amounted to 40½ per cent. of the substance taken. The following determinations were made:

Specific gravity, 15° C	1.0335
Total solids	8.14
Glucose	.94
Sucrose	.13
Total acid as acetic	2.71
Total acid as lactic	3.06

In the original substance was found:

	Per cent.
Total acid	2.15
Lactic acid	.56
Acetic acid	1.59

This sample may be regarded as an extreme of acidity owing to its having been out of the silo two days before examination. Mr. Roberts, however, feeds it after five or six days.

The second specimen, given in the table as from R. F. Roberts, Alexandria, Va., contained 47½ per cent. of juice, in which was found:

Total acid as acetic	2.12 per cent.
Lactic acid	Traces.

The presence of lactic acid in the specimens under examination was proved as follows: The filtered juice was treated with an excess of carbonate of zinc, and after removal of the undissolved portion and slight evaporation there separated crusts of a salt which on recrystallization and analysis gave the following figures:

	Per cent.
H_2O	18.46
ZnO	26.71

corresponding to zinc lactate.

The composition of the nitrogen free extract of the specimens examined has been determined roughly as follows:

	Poughkeepsie sample.	Alexandria sample.
N. free extract in 100 parts	12.87	11.24
Resinous substance	6.32	7.79
Organic acids, sugars, amido bodies, and products of fermentation	31.27	35.87
Gum	5.82	4.24
Lignin, incrusting matter, &c., soluble in acids and alkali	56.59	52.10

Or, calculating the whole analysis to dry substance—

	Poughkeepsie.	Alexandria.
Dry substance	25.90	22.70
Ash	5.72	8.87
Fat and acid	6.73	7.91
Resinous	8.14	8.86
Sugar, &c	15.54	17.76
Gum	2.89	2.10
Acid and alkali extract	28.12	25.78
Fiber	27.19	25.15
Albumen (N. × 6.25)	10.67	8.57

The following analysis of Egyptian Sugar Corn is given for comparison:

Ash	7.39
Fat, &c	2.89
Resins, &c	7.17
Sugars, &c	20.32
Gum, &c	2.39
Acid and alkali extract	31.37
Fiber	20.15
Albumen (N. ×6.25)	8.32

From this it would appear that certain substances included in the acid and alkali extract must undergo changes during the process of preservation, and become much more soluble.

The nitrogen seems to undergo little change as far as we can judge at present chemically, for in the sample from C. H. Roberts, Poughkeepsie, of the total nitrogen, only 37.4 per cent. was in the non-albuminoid form after removal from the silo for two days—an amount not larger than would be expected in the fresh stalk.

In conclusion, I desire to call attention to the increasing necessities of this division, arising from the steadily increasing work which is demanded in it.

A pressing need is for better laboratory facilities. At the present time the laboratory is located in one end of the building, for which, in its construction, no proper arrangements were made fitting it for a laboratory, and in consequence many necessary operations of a chemical laboratory are impossible, and can only be conducted, if at all, with great risk to the health of the operator, and with limited means for the proper performance of the work.

An increased force of assistants for the work of this division, for this work could be easily increased to an amount far beyond the ability of the present force to perform. The correspondence alone which naturally falls to this division is sufficient to employ the time of a competent clerk.

It is also most desirable that a small tract of land be secured within easy access to the Department for the purpose of growing such grasses, vegetables, or other plants as are under examination, for the purpose of studying their composition, physiological development, and nutritive value at different periods in their growth.

Such a tract of land would be desirable also upon which could be conducted a series of experiments tending to show the relative agricultural value of the various fertilizing constituents upon the several crops.

It would be desirable if this division could have facilities for entering upon certain experiments in feeding animals, in order to determine, so far as possible, experimentally, the relative food value of such materials as are in general use in this country, in order to supplement the results derived now solely from chemical analysis, and in this way obtain conclusions of greater practical value.

Finally, I desire to publicly acknowledge my appreciation of the faithful and efficient work which has been rendered by those engaged with me in the labors of this division, and to whom of necessity the work recorded has been largely intrusted. In the sugar investigations with sorghum and maize, the selection of canes for daily examination, and the observations in the field, as also the series of experiments illustrating the action of lime upon sugar solutions, was intrusted to Mr. Charles Wellington; the chemical investigations in connection with the work of the large mill to Mr. Henry B. Parsons; the experimental work with the small mill to Mr. William P. Wheeler and Mr. John Dugan; the analytical work upon the juices and sirups from sorghum and maize to Mr. Miles Fuller, who polarized the same; Mr. Charles Parsons, who performed the titrations; Prof. Henri Erni, who determined the acidity, and Mr. Markendorf, who determined the total solids; Messrs. Trescot, Menke, Wheeler, and Dugan assisted in other portions of the analytical work, to each and all of whom praise is due for its faithful performance.

In the other work of this division Mr. Clifford Richardson had charge of the current work, being assisted in the analytical work by Messrs. Knorr, Fuller, Markendorf, Wheeler, C. Parsons, Trescot, and Dugan, and to Mr. Richardson was intrusted the preparation of the report from page 535.

Respectfully submitted.

PETER COLLIER,
Chemist.

HON. GEO. B. LORING,
Commissioner.

REPORT OF THE STATISTICIAN.

SIR: I have the honor to present my fourteenth annual report as Statistician of the Department, it being the nineteenth since the establishment of the Division of Statistics. The series of previous reports covered the period from 1865 to 1877, inclusive.

The functions of the division always contemplated the collection and exposition of general statistics of agriculture, but the means and facilities provided have been inadequate to complete success in an undertaking so large and so rapidly widening. A crop-reporting system was adopted, which had been practiced to a limited extent in Germany, where it is now in use, upon the plan of making comparisons in percentages rather than in vague and ever-varying expressions, which cannot be reduced to mathematical equivalents, and which a dozen different readers would interpret with as many varying results. It was necessary not only that reports should be susceptible of tabulation, but that they should cover a known and well-defined area; and thus the county, with its ascertained numbers, crop areas, and amount of production, became the basis of comparison.

This system has been adopted by several State boards and departments of agriculture, and other States have in contemplation an early effort in this direction. The people have become familiar with the plan, the ignorant are forgetting their prejudices against the assumed impertinence of statistical inquiries, and the work is becoming so popular that newspaper and commercial firms are vieing with each other in the volume and variety of their crop reports. These results are indications of the growing interest in the subject; they also create some confusion in the public mind, from their variable and often contradictory tenor, which should be corrected by the superior completeness and accuracy of Department results. It will be my constant aim to secure such superior efficiency of the official crop-reporting system.

Believing that the unadorned truth will best promote the interests of producer and consumer, it will be my endeavor to eliminate bias and prejudice from returns and from the work of interpreting and averaging these local estimates. The fact that speculation, gambling in food products of the people, is alert in issuing false and exaggerated reports of crop production, and successful in securing their publication under circumstances tending to gain for them public credence, renders necessary the most prompt and accurate official information of the condition and ultimate yield of all our staple crops.

THE CROPS OF 1881.

While a crop failure, or such scarcity as to limit necessary consumption of food, is practically unknown in this country, the nearest approach to it for many years occurred in 1881. It affected all the cereals except oats, the potato crop to a very serious extent, and reduced the production of cotton more than a million bales. Five consecutive seasons, from 1876 to 1880, inclusive, produced crops of more than average yield, while the same period in Western Europe was attended with medium or low production in nearly all branches of farm industry, but especially in wheat. In 1875, the wheat product was reduced, while the corn crop was above an average. In 1874, the reverse was true, wheat making an average crop, and corn nearly as bad a failure as in 1881. In 1869, corn was a comparative failure, while wheat produced more than an average yield. In no season since the inauguration of crop-reporting has there been so general disaster, involving corn, wheat, barley, buckwheat, and rye, oats alone being exempt from loss.

The aggregate of corn estimates is 1,194,916,000 bushels, grown upon 64,262,025 acres, or 18.6 bushels per acre. This is a reduction of 32 per cent. in rate of yield and 27 per cent. in absolute quantity from the crop of 1880.

The wheat crop aggregates 383,280,090 bushels, a reduction of 22 per cent., grown on 37,709,020 acres, a yield of 10.2 per acre, the lowest rate of yield yet reported for the whole country.

Rye, 20,704,950, a reduction of 27 per cent.; area, 1,789,100 acres, yielding 11.6 bushels per acre.

The product of oats is 416,481,000 bushels, against 417,885,380 in 1880. The area is 16,831,600 acres, and the yield 24.7 bushels per acre.

Barley, 41,161,330 bushels, a reduction of 9 per cent., grown on 1,967,510 acres, or the rate of 20.9 bushels per acre.

Buckwheat, 9,486,200 bushels, grown on 828,815 acres, yielding 11.4 bushels per acre.

The aggregate product of all cereals is 2,066,029,570 bushels, against 2,718,193,501, a decrease of 24 per cent.

The aggregate value of cereals grown in 1881 is greater than the total valuation for 1880.

Corn and oats, mainly consumed at home, and used interchangeably, are most affected by the failure of maize. The average value of corn has advanced from 39.6 cents in 1880, to 63.6 cents in 1881; oats from 36 to 46.4 cents; wheat has advanced from an average of 95 cents to $1.19 per bushel.

While the reduction of product of corn in the seven surplus-yielding States amounts to about four-tenths of the usual crop, the aggregate still equals 62 per cent. of the crop of the country, leaving as the production of thirty-one States and ten Territories but three-eighths of the maize product. The yield per acre, which should be 30 bushels in a year of average production, is but 21.3 bushels; yet this is larger than the average yield of the remaining States, which is 15.4 bushels. The price per bushel is less, being 55 cents instead of 81 cents, in the remaining States. The aggregate quantities, areas, and valuations are as follows:

Products.	Bushels.	Yield.	Acres.	Price.	Value.
Corn	1,194,916,000	18.6	64,262,025	$0 63.6	$759,482,170
Wheat	383,280,090	10.2	37,709,020	1 19	456,880,427
Oats	416,481,000	24.7	16,831,600	46.4	193,189,970
Barley	41,161,330	20.9	1,067,510	82.3	33,862,513
Rye	20,704,950	11.6	1,789,100	93.3	19,327,415
Buckwheat	9,486,200	11.4	828,815	86.5	8,205,705
Total	2,066,029,570	....	123,388,070	....	1,470,948,200

In comparison with these aggregates, those of the ten preceding years are presented.

Recapitulation of cereal crops of the United States.

Years.	Total production.	Total area of crop.	Total value of crop.
	Bushels.	*Acres.*	*Dollars.*
1871	1, 528, 776, 100	65, 061, 951	911, 845, 441
1872	1, 664, 331, 600	68, 280, 197	874, 594, 459
1873	1, 538, 892, 891	74, 112, 137	919, 217, 273
1874	1, 454, 180, 200	80, 051, 289	1, 015, 530, 570
1875	2, 032, 235, 300	86, 863, 178	1, 030, 277, 099
1876	1, 962, 822, 100	93, 920, 619	935, 008, 844
1877	2, 178, 934, 646	93, 150, 286	1, 035, 571, 078
1878	2, 302, 254, 950	100, 956, 260	913, 975, 920
1879	2, 437, 482, 300	102, 260, 950	1, 245, 127, 719
1880	2, 718, 193, 501	120, 926, 286	1, 361, 497, 704
1881	2, 066, 029, 570	123, 388, 070	1, 470, 948, 200
Total	21, 884, 133, 158	1, 008, 971, 223	11, 713, 584, 307
Annual average	1, 989, 466, 651	91, 724, 657	1, 064, 871, 301

What is the official crop history of this season of comparative disaster? A year so exceptional should present, from beginning to end, indications of coming failure. They were not wanting. In April the official report of condition of wheat was 86, instead of 98 for the preceding year, the worst record in ten seasons of crop reporting. In the great grain-growing States of the West condition was marked very low—but 67 in Illinois, the State of largest production, and not a single winter-wheat State of the least importance, New York and Kansas alone excepted, reported as high as 100. In June the recorded condition of winter wheat was further reduced to 75. The injury by the severity of the winter proved to be irreparable, and a loss of nearly one-fourth of the crop resulted. Unfavorable weather in spring, reported in Wisconsin, Minnesota, and Iowa, also reduced the production of spring wheat.

The June report of cotton placed average condition at 93 instead of 99 for the previous year. There was "universal mention of the backwardness of the crop, owing to a cold and late spring." In July the plant was "generally reported small and about ten days late, owing to an unfavorable spring." The September report showed a decrease from 88 to 72 in a single month. In October the figure had dropped to 66, lower than for fifteen years.

The "trade" was inclined to doubt the accuracy of this average, and claimed a crop of 6,000,000 bales at least. The sanguine objected to any view that involved a reduction of more than a fourth of a million bales, but were finally obliged to admit the loss of a million more. The October averages of the two years were, respectively, 85 and 66, showing a decrease of 23 per cent., and the product was only saved from an equal reduction by about 5 per cent. increase of area.

The Department record of the potato crop has been thoughtlessly and sometimes unfairly criticised. The early reports were favorable. It was 92 on the first of August, but the September report indicated the almost unprecedented decline of 22 points in a single month. A severe and protracted drought was nearly universal, checking growth, enfeebling vitality, and placing the crop at the mercy of blights and insects, of which the potato beetle and chinch bug took prompt and fatal advantage. The October returns showed a worse condition than those of September, the general average being reduced to 67, indicating a loss of 55,000,000 bushels. At the date of this return the crop in the northern belt of States, in which this culture is prominent, had not generally been harvested, or the full extent of the failure been developed, yet this showing of the first of October was far worse than any record of the crop since the establishment of the Division of Statistics. The difference between the rate of yield for the year 1881 and the *lowest* previous annual estimate of yield per acre is twofold greater than the full amount of the extraordinary importation of potatoes to supply the deficiency, and the reduction from the crop of the previous year is about seven times as large as that importation. However imperfect the information relative to minor crops, the results show approximately the relative crop conditions of consecutive years more accurately than has been exhibited by any unofficial agency or method. The difference between the estimates of the two years is 58,514,076 bushels.

CORN.

The estimates for the year 1881, presented in comparison with others of the decade, are in harmony with the facts of distribution, scarcity of meat products, and advance in prices. The crop is not the smallest in absolute volume of the series, but the smallest in yield per acre. The requirement of increased population, of enlarged foreign demand, for pork and beef, and especially for corn-fed beef, makes the comparative scarcity as great as in 1874, when the occurrence of a shorter crop, following a short one in 1873, raised the average price from 48 to 64.7 cents. The average price of the crop of 1881 was 63.6 cents, and would have been higher than that of 1874 if the production of 1880 had been below an average.

The following table presents the annual estimates of acreage, product, and value for a series of years. The abnormal extraordinary increase of recent years made it difficult to keep pace with advancing production, as is shown by the record for 1879, which is widely at variance with the census returns for that year. In other crops the difference is usually slight between the two records, but in the corn estimate it is evident that the Department figures are quite too low. The table should be studied in connection with the variable character of the seasons, and with the prices per bushel, as they will in the main bear close scrutiny and afford reliable evidence of comparative accuracy.

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	991,898,000	34,091,137	$478,275,900	48.2	29.1	$14 02
1872	1,092,719,000	35,526,836	435,149,290	39.8	30.7	12 24
1873	932,274,000	39,197,148	447,183,020	48.0	23.8	11 41
1874	850,148,500	41,036,918	550,043,080	64.7	20.7	13 44
1875	1,321,069,000	44,841,371	555,445,930	42.0	29.4	12 38
1876	1,283,827,500	49,033,364	475,491,210	37.0	26.1	9 69
1877	1,342,558,000	50,369,113	480,643,400	35.8	26.6	9 54
1878	1,388,218,750	51,585,000	441,153,405	31.8	26.9	8 55
1879	1,547,901,790	53,085,450	580,486,217	37.5	29.2	10 93
1880	1,717,434,543	62,317,842	679,714,499	39.6	27.6	10 91
1881	1,194,916,000	64,262,025	759,482,170	63.6	18.6	11 82
Total	13,662,965,088	525,346,204	5,883,068,121			
Annual average	1,242,087,735	47,758,746	534,824,375	43.1	26	11 20

The census record of the great corn crop of 1879, of 1,754,861,535 bushels, arranged by groups of States for the purpose of showing the supply in proportion to population, and to cattle and swine, makes an average product of 35 bushels per capita. As the Lake States, with 21.8 bushels, have no surplus, and the South, with 18.1 bushels, buy some corn from the West, only the seven central States bordering on the Ohio and Missouri (and Kentucky and Tennessee, to a certain extent) have corn for shipment and exportation. The proportion of cattle, and especially of swine, bears intimate relation to the supply of corn, as is seen in the record of the seven central Western States, which produce nearly seven-tenths of the crop of the United States.

The following tables contrast the highest and lowest production of recent years, the figures for 1879 being those of the census of the United States, and those of 1881 the estimates of this division:

Statement showing the distribution of corn in 1879 (according to the census), by groups of States, with reference to requirements for consumption.

Group of States.	Corn crop of 1879.	Quantity per 100 of population.	Cattle per 100 of population.	Swine per 100 of population.	Population.
	Bushels.	*Bushels.*	*No.*	*No.*	
New England	8,376,133	209	37	7	4,010,529
Middle States	86,741,980	815	41	21	10,643,486
Southern Atlantic and Gulf States	235,248,849	1,809	81	94	13,001,287
Kentucky and Tennessee	135,616,692	4,250	51	137	3,191,049
Central Western States	1,201,841,335	8,905	93	186	13,495,727
Lake States	81,528,772	2,184	72	66	3,733,207
Pacific States and Territories	5,512,774	265	113	45	2,080,498
Total	1,754,861,535	3,499	72	95	50,155,783

NOTE.—The States comprising these several groups are as follows:
1. *New England States.*—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.
2. *Middle States.*—New York, New Jersey, Pennsylvania, Delaware.
3. *South Atlantic and Gulf.*—Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas.
4. Kentucky, Tennessee.
5. *Western Central.*—Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, Nebraska.
6. *Lake States.*—Michigan, Wisconsin, Minnesota.
7. *Pacific States and Territories.*—Colorado, Nevada, California, Oregon, Territories.

Statement showing the distribution of corn in 1881 (according to estimates of the Department of Agriculture), by groups of States, with reference to requirements for consumption.

Group of States.	Corn crop of 1881.	Quantity per 100 of population.	Cattle per 100 of population.	Swine per 100 of population.	Population.
	Bushels.	*Bushels.*	*No.*	*No.*	
New England	7,476,000	179	36	7	4,170,950
Middle States	65,453,000	589	39	20	11,122,443
Southern Atlantic and Gulf States	217,152,000	1,591	77	89	13,651,351
Kentucky and Tennessee	87,856,000	2,622	49	131	3,350,601
Central Western States	737,759,000	5,157	87	176	14,305,471
Lake States	70,360,000	1,778	68	62	3,957,199
Pacific States and Territories	8,860,000	404	123	43	2,194,925
Total	1,194,916,000	2,265	68.1	90	52,752,940

The progress of thirty years has been so remarkable in the corn production of these seven central States which yield all the surplus worth considering, that the record is given in detail:

States.	1849.	1859.	1869.	1879.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
Ohio	59,078,695	73,543,190	67,501,144	111,877,124
Indiana	52,964,363	71,588,919	51,094,538	115,482,300
Illinois	57,646,984	115,174,777	129,921,395	325,792,481
Iowa	8,656,799	42,410,686	68,935,065	275,024,247
Missouri	36,214,537	72,892,157	66,034,075	202,485,723
Kansas	....	6,150,727	17,025,525	105,729,325
Nebraska	....	1,482,080	4,736,710	65,450,135
Total	214,561,378	383,242,536	405,248,452	1,201,841,335

In noting the great increase since 1869, it should be remembered that the crop of that year was a partial failure, and that the area planted should have yielded 550,000,000 instead of 405,000,000 bushels. A comparison with the remaining States will make a more striking showing.

Years.	Seven States.		Thirty-one States and Territories.	
	Bushels.	*Per cent.*	*Bushels.*	*Per cent.*
1849	214,561,378	36.2	377,509,726	63.8
1850	383,242,536	45.7	455,550,206	54.3
1869	405,248,452	53.3	355,696,097	46.7
1879	1,201,841,335	68.5	553,020,200	31.5

In 1849, three-tenths of the crop was grown in the States touching the Atlantic coast; in 1879 only 12 per cent. In the central belt, including all States between the first named and the Mississippi River, the proportion has gradually declined from 58 to 46 per cent. The country west of the Mississippi, coming in with 12 per cent. thirty years ago, now yields 42 per cent. of the crop, as appears in the following statement:

Section.	1849.	1859.	1869.	1879.
Atlantic coast	30	24	20	12
Central belt	58	55	53	46
Trans-Mississippi belt	12	21	27	42

The progress westward is best shown by a meridian line dividing the crop into eastern and western halves, which may thus be represented for four decennial periods:

Years.	Crop, in bushels.	Central meridian.
		° ′
1849	592,071,104	85
1859	838,792,742	86 30
1869	760,944,549	88
1879	1,754,861,535	89 25

The distance traversed, calculated on the line of 40° north latitude, during this thirty years of progress westward, has averaged 7.8 miles per annum, or 234 miles in all, from a line running through the eastern line of counties in Indiana to a longitudinal line running a little east of Springfield, Ill.

The question has been frequently asked, What is the necessary consumption of maize per capita in the United States? No fixed quantity can be designated as a necessity in the whole country, or in a particular State. It depends not only upon the numbers of people, but upon the farm animals to be fed and fattened, and the comparative quantity and price of hay and forage, and all substitutes for corn which may be used in larger proportion in a season of scarcity. The West, under existing circumstances, can consume 55 bushels for each unit of population, ship 30, and have 5 as a surplus; or with 800,000,000 instead of 1,200,000,000 bushels, it can, by economy and substitution, make 40 bushels answer, and ship 20, the increased price naturally reducing both consumption and exportation. A reduction of over 500,000,000 in a single year has had this effect: It has increased the price more than 50 per cent. and advanced the average price of swine, sold for packing, to 31 per cent.; the actual average of 1881-'82. It increased the cost of beeves, but not in that proportion, as they are the growth of three or four years, and not of a single season, and the product of grass rather than corn. But when, during the planting season of 1882, there was prospect of another failure, a panic seized the beef market, and the advance was temporarily 30 per cent. additional.

The comparison of production of corn by States, according to the population in June, 1880, and the crop of the preceding calendar year, gives precedence to Iowa as the first in rank, with 169.3 bushels to each inhabitant. Nebraska claims the second place, with 144.7 bushels, Kansas has 106.1 bushels, and Illinois 105.9 bushels. The State first in actual quantity is therefore fourth in per capita standing. There are but nine States that have more than 30 bushels per head. The fifth in rank, Missouri, has 93.4 bushels; sixth, Indiana, 58.4; seventh, Kentucky, 44.2; eighth, Tennessee, 40.7; ninth, Ohio, 34.9. New England, New York, New Jersey, the Pacific coast, and the Territories, exclusive of Dakota, have each less than 10 bushels per head. The following table shows the details of this distribution:

Product of corn per capita, census of 1880.

States.	Population.	Acres.	Product.	Per capita.
			Bushels.	
Maine	648, 936	30, 997	960, 633	1. 5
New Hampshire	346, 991	36, 612	1, 350, 248	3. 9
Vermont	332, 286	55, 249	2, 014, 271	6. 1
Massachusetts	1, 783, 085	53, 344	1, 797, 593	1
Rhode Island	276, 531	11, 893	372, 967	1. 3
Connecticut	622, 700	55, 796	1, 880, 421	3
New England	4, 010, 529	243, 891	8, 376, 133	2. 1
New York	5, 082, 871	779, 272	25, 875, 480	5. 1
New Jersey	1, 131, 116	344, 555	11, 150, 705	9. 9
Pennsylvania	4, 282, 891	1, 373, 270	45, 821, 531	10. 7
Northern Middle	10, 496, 878	2, 497, 097	82, 847, 716	7. 9

Product of corn per capita, census of 1830—Continued.

States.	Population.	Acres.	Product.	Per capita.
Delaware	146,608	202,120	3,894,264	26.6
Maryland	934,943	664,928	15,968,533	17.1
Virginia	1,512,565	1,767,567	29,106,661	19.2
Southern Middle	2,594,116	2,634,615	48,969,458	18.9
North Carolina	1,399,750	2,305,419	28,019,839	20
South Carolina	995,577	1,303,404	11,767,099	11.8
Georgia	1,542,180	2,538,733	23,202,018	15
Florida	269,493	360,294	3,174,234	11.8
South Atlantic	4,207,000	6,507,850	66,163,190	15.7
Alabama	1,262,505	2,055,929	25,451,278	20.2
Mississippi	1,131,597	1,570,550	21,340,800	18.8
Louisiana	939,946	742,728	9,906,189	10.5
Texas	1,591,749	2,468,587	29,065,172	18.3
Arkansas	802,525	1,298,310	24,156,417	30.1
Tennessee	1,542,359	2,904,873	62,764,429	40.7
Southern	7,270,681	11,040,977	172,684,285	23.8
West Virginia	618,457	565,785	14,090,609	22.8
Kentucky	1,648,690	3,021,176	72,852,263	44.2
Ohio	3,198,062	3,281,923	111,877,124	34.9
Michigan	1,636,937	919,792	32,461,452	19.8
Indiana	1,978,301	3,678,420	115,482,300	58.4
Illinois	3,077,871	9,019,381	325,792,481	105.9
Wisconsin	1,315,497	1,015,393	84,230,579	36
Ohio Valley and Lake	13,473,815	21,501,870	706,786,808	52.5
Minnesota	780,773	438,737	14,831,741	19
Iowa	1,624,615	6,616,144	275,024,247	169.3
Missouri	2,168,380	5,588,265	202,485,723	93.4
Kansas	996,096	3,417,817	105,729,325	106.1
Nebraska	452,402	1,630,660	65,450,135	144.7
Missouri Valley	6,022,266	17,691,623	663,521,171	110
California	864,694	71,781	1,993,325	2.3
Oregon	174,768	5,646	126,862	0.7
Nevada	62,266	487	12,891	0.2
Washington	75,116	2,117	39,183	0.5
Pacific	1,176,844	80,031	2,172,261	1.8
Colorado	194,327	22,991	455,968	2.3
Arizona	40,440	1,818	34,746	0.8
Dakota	135,177	90,852	2,000,864	14.8
Idaho	32,610	569	16,408	0.5
Montana	39,159	197	5,649	0.1
New Mexico	119,565	41,449	633,786	5.3
Utah	143,693	12,007	163,343	1.1
Wyoming	20,789	....	....	....
District of Columbia	177,624	1,032	29,750	0.2
Rocky Mountains and District of Columbia	903,384	170,915	3,340,514	3.7
United States	50,155,783	62,368,869	1,754,861,535	35

The movement of corn production has been constant and striking. It has been not only westward, but also northward. The seat of the production was formerly in the South. Tennessee held the first position in 1840. In 1849 fifteen Southern States produced 59 per cent. of the crop, though Tennessee had dropped to fifth in rank, preceded by Ohio, Kentucky, Illinois, and Indiana. In 1859 the Northern States had exchanged position with the South, and claimed about six-tenths of the production, Illinois taking the lead, followed by Ohio, Missouri, Indiana, Kentucky, and Tennessee. Illinois had only half a crop in 1869, yet still held the first position; Iowa came in next, and five States followed in the same order as ten years before. Illinois had in thirty years, from 1849 to 1879, exchanged the third place for the first; Missouri the sixth for the third. Indiana held still the fourth place. Ohio had dropped from the first to the fifth, Kentucky from the second to the seventh, and Tennessee from the fifth to the ninth. Iowa, Kansas, Nebraska, and Pennsylvania came into the list, and Virginia, Georgia, Alabama, and North Carolina, which stood at the bottom of the first list, failed to appear in that of 1879.

Table showing the ten largest corn-producing States in the census years of 1849, 1859, 1869, *and* 1879.

No.	States.	1849.	No.	States.	1859.
		Bushels.			*Bushels.*
1	Ohio	59, 078, 695	1	Illinois	115, 174, 777
2	Kentucky	58, 672, 591	2	Ohio	73, 543, 190
3	Illinois	57, 646, 984	3	Missouri	72, 892, 157
4	Indiana	52, 964, 363	4	Indiana	71, 588, 919
5	Tennessee	52, 276, 223	5	Kentucky	64, 043, 633
6	Missouri	36, 214, 537	6	Tennessee	52, 089, 926
7	Virginia	35, 254, 319	7	Iowa	42, 410, 686
8	Georgia	30, 080, 099	8	Virginia	38, 319, 999
9	Alabama	28, 754, 048	9	Alabama	33, 226, 282
10	North Carolina	27, 941, 051	10	Georgia	30, 776, 293

No.	States.	1869.	No.	States.	1879.
		Bushels.			*Bushels.*
1	Illinois	129, 921, 395	1	Illinois	325, 792, 481
2	Iowa	68, 935, 065	2	Iowa	275, 024, 247
3	Ohio	67, 501, 144	3	Missouri	202, 485, 723
4	Missouri	66, 034, 075	4	Indiana	115, 482, 300
5	Indiana	51, 094, 538	5	Ohio	111, 877, 124
6	Kentucky	50, 091, 006	6	Kansas	105, 729, 325
7	Tennessee	41, 343, 614	7	Kentucky	72, 852, 263
8	Pennsylvania	34, 702, 006	8	Nebraska	65, 450, 135
9	Texas	20, 554, 538	9	Tennessee	62, 764, 429
10	North Carolina	18, 454, 215	10	Pennsylvania	45, 821, 531

Exportation.—The exportation of corn has been about 6 per cent. of the production during the last decade, or twice the proportion of the previous five years. At earlier periods the shipments to foreign countries have fluctuated greatly from a fraction of 1 per cent. to 3 per cent. of the crop. It has never been sufficient to control or greatly modify home prices. When prices have been high at home exportation has been greatly checked; when very low, larger shipments have been found desirable, in supplementing the feeding stuffs of Europe, with which corn competes. It has ever been, until recently, an inconsiderable element in such feeding material, a convenience for limited uses, rather than a necessity to be had without regard to price. The great increase of the latest period of five years has been mainly due to great abundance and low price; in part, to the increasing appreciation consequent upon enlarged use. The following table from the Treasury records, as arranged by the Bureau of Statistics, will illustrate these views:

Table showing quantities and values of corn and corn meal exported from 1859 *to* 1881 *inclusive.*

Years ending June 30.	Corn.	Corn meal.	Total corn.	Corn.	Corn meal.	Total corn.
	Bushels.	*Barrels.*	*Bushels.*			
1859	1,719,998	258,885	2,755,538	$1,323,103	$994,269	$2,317,372
1860	3,314,155	233,709	4,248,991	2,399,808	912,075	3,311,883
1861	10,678,244	203,313	11,491,496	6,890,865	692,003	7,582,868
1862	18,904,909	253,570	19,919,180	10,387,383	778,344	11,165,727
1863	16,119,476	257,948	17,151,268	10,592,704	1,013,372	11,606,076
1864	4,096,694	262,357	5,146,122	3,353,280	1,349,765	5,703,045
1865	2,812,726	99,419	3,210,402	3,679,133	1,489,886	5,169,019
1866	13,516,651	237,275	14,465,751	11,070,395	1,129,484	12,199,879
1867	14,889,823	284,281	16,026,947	14,871,092	1,555,585	16,426,677
1868	11,147,490	336,508	12,493,522	13,094,036	2,068,430	15,162,466
1869	7,047,197	309,867	8,286,665	6,820,719	1,656,273	8,476,992
1870	1,392,115	187,093	2,140,487	1,287,575	935,676	2,223,251
1871	9,826,309	211,811	10,678,553	7,458,997	951,830	8,410,827
1872	34,491,650	308,840	35,727,010	23,984,365	1,214,999	25,199,364
1873	38,541,930	403,111	40,154,374	23,794,694	1,474,827	25,269,521
1874	34,434,606	387,807	35,985,834	24,769,951	1,529,399	26,299,350
1875	28,858,420	291,654	30,025,036	24,456,937	1,290,533	25,747,470
1876	49,493,572	354,240	50,910,532	33,265,280	1,305,027	34,570,307
1877	70,860,983	447,907	72,652,611	41,621,245	1,511,152	43,132,397
1878	85,461,098	432,753	87,192,110	48,030,358	1,336,187	49,366,545
1879	86,296,252	397,160	87,884,892	40,655,120	1,052,231	42,707,351
1880	98,169,877	350,613	99,572,329	53,298,247	981,361	54,279,608
1881	91,908,175	434,993	93,648,147	50,702,669	1,270,200	51,972,869
1882	43,184,915	288,942	44,340,683	28,845,830	994,201	29,840,031

A glance at this table will prove that exportation of corn has little influence upon price; at least, that the home demand, from the relative scarcity or abundance of production, is the controlling factor in fixing price. The value at ports of shipment was 55 cents in 1880, and the quantity shipped within a fraction of one hundred million bushels. On the other hand, in 1870 the export price was $1.04, and the shipments amounted only to a fraction above two millions. The price controls mainly the foreign demand; that demand affects only in small degree the prices in this country.

WHEAT.

The crop of 1881, grown upon a breadth greater, with one exception, than ever before reported, was the smallest since 1877, with a lower yield per acre than any of which official record is made. The average of 11 years is 12.2 bushels per acre, ranging from 13.9 in 1877 to 10.2 in 1881. The average price, on the basis of farm valuation, in December, is $1.19, which is higher than that of any crop since 1872. While the price of corn is determined mainly by the per capita supply, the exportation being only 3 to 6 per cent., the value of wheat depends upon the combined production of Europe and America, three to four tenths of the crop being shipped abroad in seasons of European scarcity. The following statement presents the estimates of area, product, and value for a period of eleven years:

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	230,722,400	19,943,893	$290,411,820	125.8	11.5	$14 56
1872	249,997,100	20,858,359	310,180,375	124	11.9	14 87
1873	281,254,700	22,171,676	323,594,805	115	12.7	14 59
1874	309,102,700	24,967,027	291,107,895	94.1	12.3	11 66
1875	292,136,000	26,381,512	294,580,990	100	11	11 16
1876	289,356,500	27,627,021	300,259,300	103.7	10.4	10 86
1877	364,194,146	26,277,546	394,695,779	108.2	13.9	15 06
1878	420,122,400	32,108,560	326,346,424	77.7	13.1	10 16
1879	448,756,630	32,545,950	497,030,142	110.8	13.8	15 27
1880	498,549,868	37,986,717	474,201,850	95.1	13.1	12 48
1881	380,280,090	37,709,020	453,790,427	119	10.1	12 03
Total	3,764,472,534	308,577,281	3,956,199,807	....	....	....
Annual average	342,224,776	28,052,480	359,654,528	105.1	12.2	12 82

With an increase of thirteen millions in population from 1871 to 1882, and an increased exportation of 130,000,000 bushels, we should require twice as much wheat, and the apparent increase of area is found to be 90 per cent.

Wheat is a crop grown in all the States and Territories, though very unequally, some States producing scarcely a week's supply. The New England States together grow only a sufficiency for three weeks, the Middle States obtain three-tenths of their wheat from the West, and the South has a deficiency quite as large. Kentucky and Tennessee produce breadstuffs for home consumption, and sometimes a small quantity toward filling the Southern demand. The States that have any considerable surplus of wheat are those north of the Ohio River, those of the Missouri Valley, and of the Pacific coast. Twelve States and two Territories complete the list of reliable surplus wheat producing States.

Where and by whom is this surplus used? By an analysis of the facts of production, local distribution, and exportation, we are able to fix with considerable precision the local consumption. Yet the production varies annually, sometimes 20 per cent. or more in a single year. Consumption is increased by augmenting population, and great scarcity with high prices may somewhat diminish the per capita rate. All these changes add to the difficulties of calculating the distribution of each crop.

Yet the writer four years ago attempted to show what had become of the assumed crop of 1877, believing that similar calculations for subsequent years would verify the accuracy of the estimates of production, if substantially correct, or show wide and increasing discrepancies if the bases of these calculations were unfounded and untrue. First, the reserve for seed, a large proportion of it to be planted soon after ripening, requires a bushel and a half per acre, as established by a careful investigation. Next, the exportation of the following fiscal year, which corresponds with sufficient nearness to the crop year, which can be given in actual bushels. The remainder is left for consumption, almost exclusively as food for man. This requirement for local consumption, the distribution of the supply, is not blindly assumed, but is fixed after investigation of the facts of transportation to the South, to the Eastern seaboard, after examination of flour-manufacturing data, and all facts that bear upon local differences in rate of consumption.

Without attempting too minute characterization of local differences in rate of consumption, but averaging for large groups of States, the assumed supply of twelve States, from Maryland to Texas, is placed at 4 bushels. A very large proportion of corn is used in this region, by all classes, and especially by the great masses of laborers; in some districts the consumption of wheat is not half the average for the whole country. In Maryland and Virginia the proportion is much greater than in Alabama or Mississippi, yet 4 bushels is probably an excessive rather than a deficient supply for the whole region. In Kentucky and Tennessee the average is placed at 4½ bushels. In the great wheat-growing States, and in the Middle and Eastern States, wheat is more exclusively used for bread, though corn, rye, and buckwheat are consumed to a limited extent, and 5 bushels are allowed. This makes an average of fully 4⅝ bushels, or a full barrel of flour, to each inhabitant throughout the country—more in some States, less in others.

Upon such basis the following table is constructed, showing the distribution of the estimated production of 1877, according to the population of the spring of 1878:

WHEAT, 1877.

Group of States.	Production.	Consumption.		Surplus.	Deficiency.
		For bread.	For seed.		
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
New England	1,174,800	20,055,560	104,800		18,985,560
Middle	34,180,000	51,380,970	3,514,683		20,715,653
South Atlantic and Gulf	37,250,000	46,384,012	6,814,150		15,948,162
Kentucky and Tennessee	18,550,000	13,929,466	2,893,714	1,726,820	
Western Central	161,450,000	66,875,215	16,360,060	78,214,725	
Lake	77,214,346	17,141,980	6,778,260	53,294,106	
Pacific and Territories	34,375,000	7,535,180	4,447,641	22,392,179	
	364,194,146	223,302,383	40,913,308	155,627,830	55,649,375

The net surplus, after supply of States not self-supporting, is 99,978,455, of which 90,167,959 are sent to foreign countries during the fiscal year, leaving a small balance to eke out the supply of the following year.

These groups, with more than half the population of the country, produce scarcely one-fifth of the crop. Two other groups, inhabited by two-thirds as many people, produce a surplus of 131,508,831 bushels.

This showing of the consumption of 1877–'78 looked well enough for that year. Would similar calculations, applied to future estimates and future changes in exportation and seeding and increase of population, fit equally well the new estimates of production? If not, then an error, either in the estimate or in the distribution, is probable.

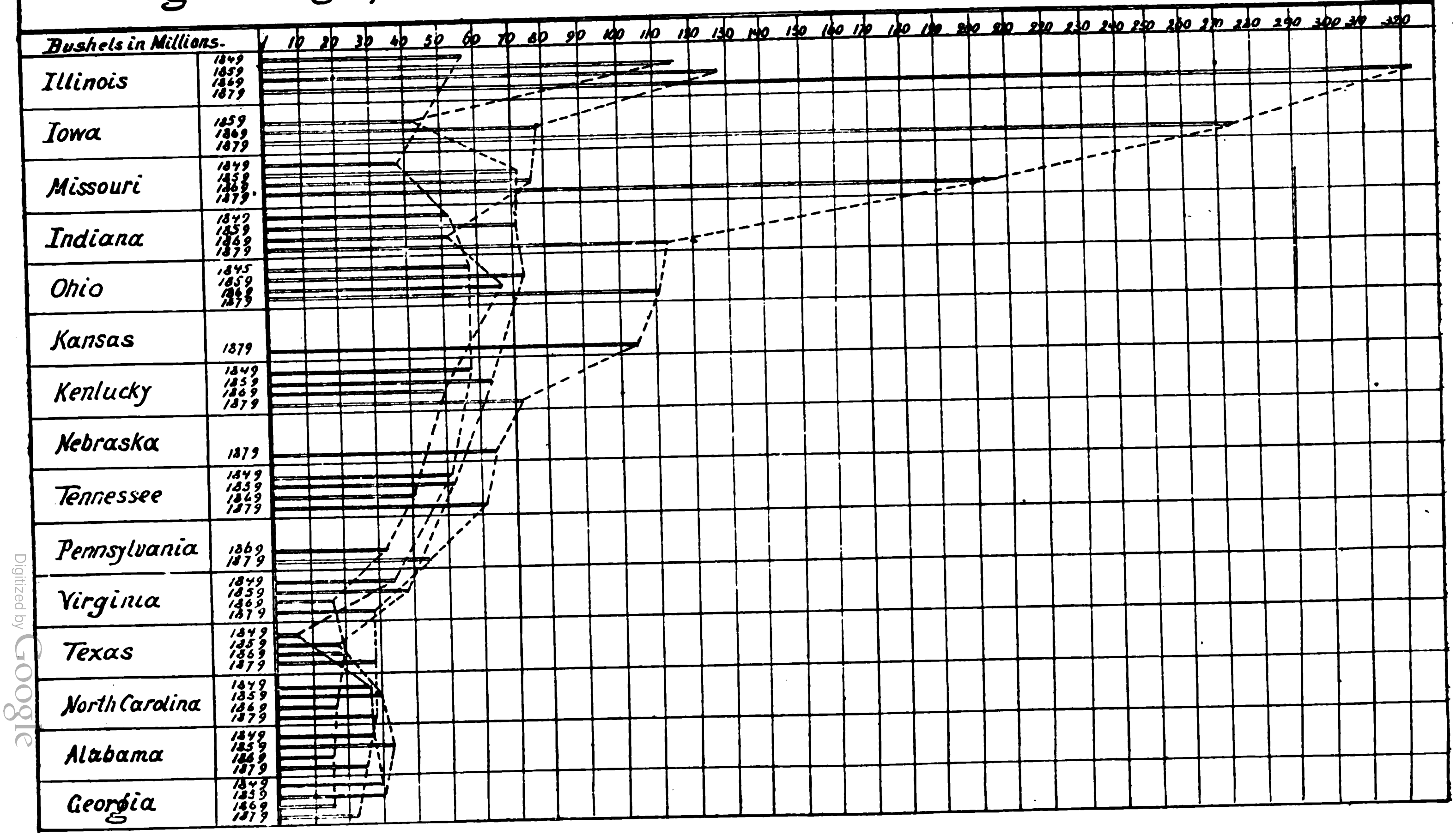
The next year, 1878, allowing 2½ per cent. increased consumption for augmented population, over 8,000,000 bushels more of seed for enlarged acreage, and an immense advance in exportation to 147,687,649 bushels, the distribution aggregates the high figure of 424,728,467 bushels. The estimate of the Department of Agriculture for 1878 was 420,122,400 bushels.

So far the test is a close one. In these two years the combined figures for distribution make a sum a few millions less than the assumed production, with no encroachment upon the average surplus stock (available for food) in the hands of farmers and dealers at the beginning of the trade year, which may amount to 40,000,000 or 50,000,000 bushels. The next crop is that of the census year 1879, and we take the figures of the census to represent its production. We use the same calculations, taking the ascertained population of 1880, the census area, and the official exportation, with the following result:

WHEAT, 1879.

Group of States.	Production.	Consumption.		Surplus.	Deficiency.
		For bread.	For seed.		
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
New England	1,227,037	20,052,645	118,504		18,944,112
Middle	34,127,182	53,217,430	3,628,941		22,719,189
South Atlantic and Gulf	32,940,094	52,005,148	6,066,609		25,131,663
Kentucky and Tennessee	18,687,466	14,359,720	3,535,006	792,740	
Central Western	231,702,204	67,478,635	25,273,960	138,949,589	
Lake	95,018,262	18,666,035	10,223,368	66,128,859	
Pacific and Territories	45,777,260	10,402,490	4,298,668	31,076,102	
Total	459,479,505	236,182,103	53,145,076	236,947,290	66,794,964

Diagram showing the production of Corn for the year 1849-1859-1869-1879 by the principal Corn producing States.



The exportation of 180,304,180 bushels of wheat in the year 1879–'80 drew heavily upon the crop of 1879, reducing the reserve stock in sight on the first of August, 1880, and evidently also the reserves not in sight in the hands of the farmers. Consequently we are not surprised to find that the distribution amounts to 10,000,000 bushels more than the production of the previous year. We now find that the aggregate yield of three years (by the census and two previous estimates) is 1,243,000,000 bushels, and the distribution, covering as nearly as possible the same crops, 1,248,000,000. Certainly we can discover no discrepancy up to this point.

Two more crops have since been garnered. Will the harmony between apparent production and consumption still continue? Let us see. The largest product ever made is reported in 1880, amounting to 498,549,868 bushels. Allowing 2½ per cent. for increase of population, the consumption is 242,086,655 bushels. For seed the requirement is increased to 56,563,530 bushels. The exportation, the largest ever known in this or any other country, is 186,321,214 bushels. The total distribution is 484,971,399 bushels, leaving a surplus of 13,578,469 bushels, which is needed to eke out the diminished supply of the following year.

Coming to the year 1881, in which the reduction of more than 100,000,000 bushels is noted, and in which the price has advanced higher than for many previous years, when the reserves of the farm, the commercial granary, and railroad elevator are reduced beyond all precedent, a test parallel with those of previous years is a severe one; yet we make no change in the basis of calculation, except that, in consideration of extraordinary prices and enforced economy in living, it is deemed not only fair but necessary to recognize a possible difference in consumption, and a fourth of a bushel is therefore deducted from the per capita allowance of each section; a small difference, but a large limitation might be construed into accommodation to the greatly diminished estimate of production, and an assertion of a theory of wide fluctuation in the rate of consumption of wheat, which is not probable, the wheaten loaf being more nearly a fixed quantity in an American's dietary than any other article of food. Should no allowance for diminished consumption be insisted on, it increases the amount consumed less than 13,000,000 bushels, which would not require an excessive drain on average reserves in farmers' hands. The showing for 1881–'82 is as follows:

WHEAT, 1881.

Group of States.	Production.	Consumption.		Surplus.	Deficiency.
		For bread.	For seed.		
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
New England	1, 228, 260	19, 812, 012	119, 371		18, 703, 123
Middle	32, 703, 000	52, 831, 604	3, 770, 826		23, 899, 430
South Atlantic and Gulf	33, 328, 830	51, 192, 566	6, 917, 947		24, 781, 683
Kentucky and Tennessee	15, 033, 000	14, 240, 054	3, 847, 362		3, 054, 416
Central Western	169, 091, 000	67, 950, 987	25, 655, 542	75, 484, 471	
Lake	75, 159, 000	18, 706, 695	9, 161, 289	47, 201, 016	
Pacific and Territories	56, 737, 000	10, 425, 894	5, 743, 236	40, 567, 870	
Total	383, 280, 090	235, 249, 812	55, 215, 573	163, 253, 357	70, 438, 652

The deficiency of the seaboard and Gulf States is greater than usual, and Kentucky and Tennessee fail to produce the 4¼ bushels per capita assumed as their food requirement. The surplus of the grain-growing States is small. The net overplus of 200,000,000 bushels in 1880 has been reduced nearly 60 per cent. The current annual exportation, though less than two-thirds of that of 1880–'81, exhausts this surplus, and also reduces to the lowest limit (in many years) the usual reserves on hand in farmers' bin or merchants' granary at the close of each crop year.

Summing up the results of these calculations, it is seen that the distribution of two years is less by a very small margin than the production. In two other years it is more by an equally small difference; and only in the last year is there an apparent discrepancy, which is fully accounted for by the diminished stocks in hands of growers and dealers as compared with the large surplus of August 1, 1881, when possibly 45,000,000 bushels, exclusive of seed, were in existence east of the Rocky Mountains and 20,000,000 on the Pacific coast. The recapitulation is as follows:

Years.	Production.	For food.	For seed.	Exportation.	Total distribution.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1877	364, 194, 146	223, 302, 383	40, 913, 308	90, 167, 959	354, 383, 650
1878	420, 122, 400	228, 877, 978	48, 162, 840	147, 687, 649	424, 728, 467
1879	459, 479, 505	236, 182, 103	53, 145, 076	180, 304, 180	469, 631, 359
1880	498, 549, 868	242, 086, 655	56, 563, 530	186, 321, 214	484, 971, 399
1881	383, 280, 090	235, 249, 812	55, 215, 573	121, 892, 389	412, 357, 774
Total	2, 125, 626, 009	1, 165, 698, 931	254, 000, 327	726, 373, 391	2, 146, 072, 649
Average	425, 125, 202	233, 139, 786	50, 800, 065	145, 274, 678	429, 214, 530

The result is an estimated production of 2,122,626,009 bushels in five years, and a distribution of 2,146,180,260 bushels, an excess of 20,554,251 bushels. If this represents truly the facts of production and distribution, it shows that the surplus on hand at the close of the wheat year, August 1, 1882, was about 20,000,000 bushels less than at the same date in 1877. It is certain that the unexampled exhaustion of stocks, in consequence of last year's diminished product, did reduce stocks to that extent at least. A few facts will make this matter plain.

The early exhaustion of the surplus is indicated by results of returns of wheat on hand March 20, 1882 (four months before the close of the wheat year), compared with the quantity on hand March 20, 1881, in the following States, which furnish a large proportion of the surplus of wheat:

States.	March 20, 1882.		March 20, 1881.	
	Per cent. of crop.	Bushels.	Per cent. of crop.	Bushels.
Ohio	25	9, 630, 000	30	14, 937, 143
Indiana	18	5, 643, 540	28	13, 934, 693
Illinois	19	6, 830, 880	24	9, 694, 967
Iowa	23	4, 197, 040	28	9, 269, 807
Missouri	17	3, 467, 830	28	8, 277, 678
Kansas	15	2, 986, 350	26	5, 287, 360
Nebraska	21	2, 906, 400	23	2, 972, 216
Total	21	35, 662, 040	25	64, 393, 863

Instead of 25 per cent. on hand at that date, there was only 21 per cent., while the actual quantity on hand of the reduced crop of 1881 was less by nearly 29,000,000 bushels; a decrease of nearly half.

The reduction in the visible supply of the Atlantic coast wheat was also in very nearly the same proportion.

The comparison is as follows:

	Bushels.
March 20, 1880	25,864,237
March 19, 1881	22,907,003
March 18, 1882	13,415,924

From this time to June 24, the receipts at seaboard ports were only 10,042,838, and the visible supply (stock "in sight") had in that time been reduced 2,860,478 bushels, showing that a little more than 7,000,000 bushels had in the meantime come from all farms east of the Rocky Mountains over the through routes eastward, though a small additional quantity had been drawn from farmers for local distribution. It is evident from these facts that there was little more than half of the usual surplus.

From this exposition it may be fairly assumed that the amount of wheat required as food, in years of average abundance, is 4⅗ bushels per capita; that it scarcely ever exceeds 4¾, and rarely falls below 4½ bushels.

It may also be assumed that the estimates of production are substantially correct as to the crop, and that they assuredly are not too high, if divergent at all from the actual.

The increase of wheat production in thirty years is quite remarkable, and its progress westward equally notable. There has been an increase of (nearly) 14 per cent. on the Atlantic coast, of 427 per cent. in the Central States, and 3132 per cent. in the country beyond the Mississippi. In ten years past the increase has been 63 per cent. in the central belt and 92 in the Trans-Mississippi region, though the actual increase in bushels was greater in the former—88,388,110 against 82,120,609 bushels.

The production of each grand division is thus shown for each decennial enumeration:

Sections.	1849.	1859.	1869.	1879.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
Atlantic coast	51,657,020	53,294,137	57,476,371	58,701,531
Central belt	43,522,646	94,458,609	140,877,070	229,265,180
Trans-Mississippi	5,306,278	25,352,178	89,392,185	171,512,794
Total	100,485,944	173,104,924	287,745,626	459,479,505

The percentage proportions of each crop produced in each division are thus compared:

Sections.	1849.	1859.	1869.	1879.
Atlantic coast	51.4	30.7	20.	12.8
Central belt	43.3	54.6	49.	49.9
Trans-Mississippi	5.3	14.7	31.	37.3
	100.	100.	100.	100.

It will be seen that the proportion grown in the central belt has not declined in thirty years, though it is less than twenty years ago. In the last decade it has slightly advanced.

The most striking fact in wheat production is the increase per capita, notwithstanding the phenomenal increase in population. It was 4.33 bushels in 1849; 5.5 in 1859; 7.28 in 1860; and 9.2 in 1879. The following exhibit gives the quantity per capita, with the acreage and the population of each State.

The local changes of production are seen clearly in the accompanying diagram, which represents the ten principal wheat-growing States in each enumeration in the order of their prominence. Two States in the last list exceed the production of the whole ten of the first, and very nearly equal the entire crop of 1849. The first in 1849 literally becomes the last in 1879. Only three of the first list, New York, Maryland, and Virginia, fail to appear in the last. The tenth State in 1879, Pennsylvania, has a production considerably in excess of the first in the list of 1849, which is also Pennsylvania. Ten States in 1849 produced 86 per cent. of the crop, 75 in 1859, 79 in 1869, and 75 in 1879; *i. e.*, about three-fourths of the product is grown in less than one-fourth of the States and Territories, showing that while wheat can and may be grown in every political division of the United States, there are climatic, geological, or economic reasons for unequal and patchy distribution of this important crop. These changes are shown in the following table:

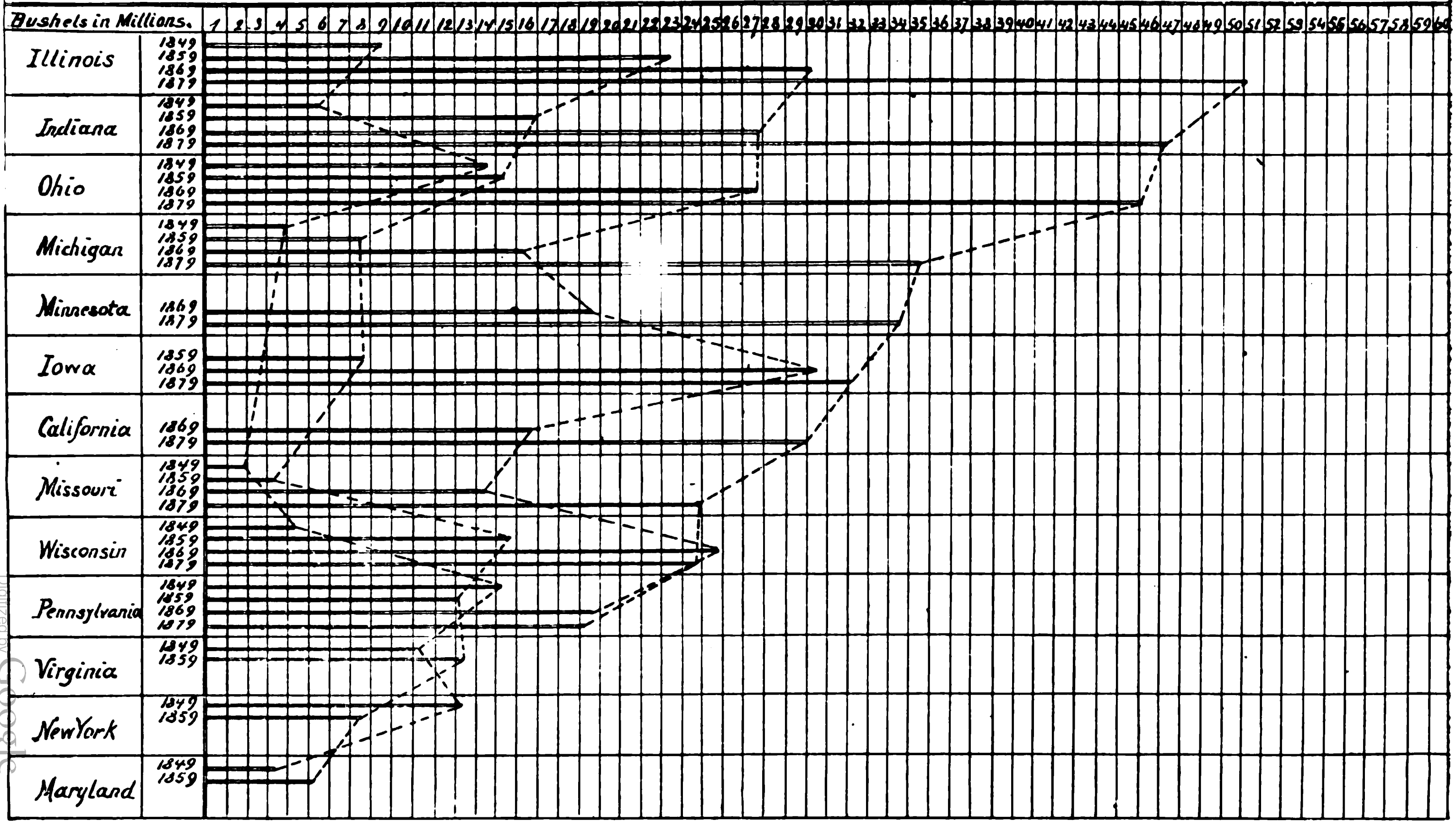
States.	1849.	States.	1859.
	Bushels.		*Bushels.*
Pennsylvania	15, 367, 691	Illinois	23, 837, 023
Ohio	14, 487, 351	Indiana	16, 848, 267
New York	13, 121, 498	Wisconsin	15, 657, 458
Virginia	11, 212, 616	Ohio	15, 119, 047
Illinois	9, 414, 575	Virginia	13, 130, 977
Indiana	6, 214, 458	Pennsylvania	13, 042, 165
Michigan	4, 925, 889	New York	8, 681, 105
Maryland	4, 494, 680	Iowa	8, 449, 403
Wisconsin	4, 286, 131	Michigan	8, 336, 368
Missouri	2, 981, 652	Maryland	6, 103, 480
Total	86, 506, 541	Total	129, 205, 293

States.	1869.	States.	1879.
	Bushels.		*Bushels.*
Illinois	30, 128, 405	Illinois	51, 110, 502
Iowa	29, 435, 692	Indiana	47, 284, 853
Ohio	27, 882, 159	Ohio	46, 014, 869
Indiana	27, 747, 222	Michigan	35, 532, 543
Wisconsin	25, 606, 344	Minnesota	34, 601, 030
Pennsylvania	19, 672, 967	Iowa	31, 154, 205
Minnesota	18, 866, 073	California	29, 017, 707
California	16, 676, 702	Missouri	24, 966, 627
Michigan	16, 265, 773	Wisconsin	24, 884, 689
Missouri	14, 315, 926	Pennsylvania	19, 463, 405
Total	226, 597, 263	Total	344, 029, 430

The rate of westward movement of wheat is greater than that of corn. Calculating the distance traversed westward on the line of the fortieth parallel (which very nearly divides the crop into northern and southern halves) at the rate of 280,135 feet to each degree of longitude, the movement of thirty years is equal to 411 miles, or 13.7 miles per annum. The center line of production passed through Eastern Ohio in 1849; through the eastern line of counties of Indiana in 1859; Eastern Illinois, in the western line of Pratt County in 1869, and the center of Illinois in 1879, as indicated in the following statement:

Years.	Crop.	Central line of longitude.
	Bushels.	
1849	100, 485, 944	81°
1859	173, 104, 924	85° 24′
1869	287, 745, 626	88
1879	459, 479, 505	88° 45′

Diagram showing the production of Wheat for the years 1849-1859-1869-1879 by the principal Wheat producing States.



The accompanying outline map of this region shows the central line dividing the crops, both of wheat and corn, at the four decennial dates.

The movement of thirty years was through 7¾ degrees of longitude. It has not been equal, more than half of the stride having been accomplished in the first ten years. Nor has the march been without retrograde, as the line of equal division of the crop was carried in 1877 fully a third of a degree farther than in 1879, when the Ohio Valley produced 180,000,000 bushels and the entire Northwest only about two-thirds as much on nearly the same area. It is possible that the movement may at some future day tend eastward after the western limit is reached. The receding eastward in 1879 was in consequence of a higher rate of yield in the older winter-wheat States, in part from better cultivation, tile-draining, and wiser management, with the aid of a propitious season. The following statement illustrates the difference in yield:

States.	Winter wheat.		States.	Spring wheat.	
	Bushels.	Bushels per acre.		Bushels.	Bushels per acre.
New York	11,587,766	15.7	Wisconsin	24,884,689	12.8
Pennsylvania	19,462,405	13.5	Minnesota	34,601,030	11.4
Ohio	46,014,869	18.0	Iowa	31,154,205	10.2
Michigan	35,532,543	19.5	Nebraska	13,847,007	9.4
Indiana	47,284,853	18.0	Dakota	2,830,289	10.7
Illinois	51,110,502	15.9			
Total	210,992,938	17.0	Total	107,317,220	11.0

The highest rate of yield in the northwest fails to equal the lowest in the great winter-wheat States east of the Mississippi. It is fair to say that the difference here presented is greater than the average difference of a series of years, yet the causes producing it act with much uniformity and certainty, and the fact enforces an important lesson in wheat husbandry.

Exportation.—The exportation of wheat assumed increased importance during the war period from the high price of gold (wheat being sold virtually for gold), and from the necessity for something in the place of cotton with which to pay for necessarily heavy imports. During those four years the average annual shipments exceeded 50,000,000 bushels. For five years thereafter the annual shipments averaged but 20,000,000. Then a new impetus was given to the trade, first from increased consumption of wheat in an era of progress and prosperity, and afterwards, when a check came to the general prosperity of the great nations of western Europe, several unpropitious seasons in succession caused a largely increased demand on our supply, which, fortunately, was ample for all demands. The high prices which resulted have greatly increased the acreage, which has been doubled in fifteen years. Since 1869 the exportation has never fallen below fifty millions, except in 1871–'72, and for four years past it has averaged 159,000,000 bushels per annum, and an export value of $187,000,000. The foreign shipments of five years have equaled the volume of exports of sixteen previous crops.

Table showing quantities and values of wheat and wheat flour exported from 1859 to 1882, inclusive.

Years.	Wheat.	Wheat-flour.	Total wheat.	Wheat.	Wheat flour.	Total wheat.
	Bushels.	*Barrels.*	*Bushels.*			
1859	3,002,016	2,431,824	13,945,224	$2,849,192	$14,433,591	$17,282,783
1860	4,155,153	2,611,596	15,907,835	4,076,704	15,448,507	19,526,211
1861	31,238,057	4,323,756	50,694,959	38,313,624	24,645,849	62,959,473
1862	37,289,572	4,882,033	59,258,720	42,573,295	27,534,677	70,107,972
1863	36,160,414	4,390,055	55,915,661	46,754,195	28,366,069	75,120,264
1864	23,681,712	3,557,347	39,689,773	31,432,133	25,588,249	57,020,382
1865	9,937,152	2,604,542	21,657,591	19,397,197	27,222,031	46,619,228
1866	5,579,103	2,183,050	15,402,828	7,842,749	18,396,686	26,239,435
1867	6,146,411	1,300,106	11,996,888	7,822,555	12,803,775	20,626,330
1868	15,940,899	2,076,423	25,284,802	30,247,632	20,887,798	51,135,430
1869	17,557,836	2,431,873	28,501,264	24,383,259	18,813,865	43,197,124
1870	36,584,115	3,463,333	52,169,113	47,171,229	21,169,593	68,340,822
1871	34,310,906	3,653,841	50,753,190	45,143,424	24,093,184	69,296,608
1872	26,423,080	2,514,535	37,738,487	38,915,060	17,955,684	56,870,744
1873	39,204,285	2,562,086	50,733,672	51,452,254	19,381,664	70,833,918
1874	71,039,928	4,094,094	89,463,351	101,421,459	29,258,094	130,679,553
1875	53,047,177	3,973,128	70,926,253	59,607,863	23,712,440	83,320,303
1876	55,073,122	3,935,512	72,782,926	68,382,899	24,433,470	92,816,369
1877	40,325,611	3,343,665	55,372,103	47,135,562	21,663,947	68,799,509
1878	72,404,961	3,947,333	90,167,959	96,872,016	25,095,721	121,967,737
1879	122,353,936	5,629,714	147,687,649	130,701,079	29,567,713	160,268,792
1880	153,252,795	6,011,419	180,304,180	190,546,305	35,333,197	225,879,502
1881	150,565,477	7,945,786	186,321,514	167,698,485	45,047,257	212,745,742
1882	95,271,802	5,915,686	121,892,389	112,929,718	36,375,055	149,304,773

OATS.

This crop in 1881 was an exception, the only cereal not seriously impaired by the vicissitudes of the season. It was not a large crop, and scarcely a medium yield. The average was 24.7 bushels per acre, the average for eleven years being 27.6 per acre. This is the lowest rate for that period, with the exception of 22 bushels in 1874. The range was from 22 to 31.6 bushels.

The value was also higher than in any year since 1870, except in 1874, when it was 52 cents. In 1880, when the yield was 25.8 bushels, slightly under an average, the price was 36 cents, precisely the average of eleven years. It would have been somewhat higher but for the extraordinary abundance and unusual cheapness of corn. So when the production of maize fell off 500,000,000 bushels in 1881, the value of oats advanced ten cents per bushel, notwithstanding the yield of 24.7 bushels, in consequence of the still greater advance of corn, these grains being used interchangeably for feeding certain farm animals.

The value per acre for this series of years is found to be about $10 per acre.

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	255,743,000	8,365,809	$102,570,030	40.1	30.5	$12.26
1872	271,747,000	9,000,769	91,315,710	33.6	30.1	10.14
1873	270,340,000	9,751,700	101,175,750	37.4	27.7	10.37
1874	240,369,000	10,897,412	125,047,530	52.0	22.0	11.47
1875	354,317,500	11,915,075	129,499,930	36.5	29.7	10.86
1876	320,884,000	13,358,908	112,865,900	35.1	24.0	8.44
1877	406,394,000	12,826,148	118,661,550	29.2	31.6	9.25
1878	413,578,560	13,176,500	101,945,830	24.6	31.4	7.74
1879	363,761,320	12,683,500	120,533,294	33.1	28.7	9.50
1880	417,885,380	16,187,977	150,243,565	36.0	25.8	9.28
1881	416,481,000	16,831,600	193,198,970	46.4	24.7	11.47
Total	3,731,500,760	134,995,398	1,347,058,059			
Annual average	339,227,342	12,272,309	122,459,823	36.1	27.6	9.98

BARLEY.

This is the only cereal crop of which a supply for home consumption is not produced in this country. While the average production since 1870 has been 36,000,000 bushels, the importation in excess of exports has been about 6,000,000. Its acreage has increased in nearly the same ratio as the area of wheat, yet the supply lags behind demand, failing to keep pace with the increase of the beer manufacture. The crop of 1881 was a small one, averaging 20.9 bushels per acre, about the same as those of 1874 and 1875, and larger than that of 1872; others of the past decade ranging upwards to 24.5 bushels. The influence of price on extension of area is well exemplified in the history of this crop. In 1872 there was a large importation, causing some reduction in price. The next year there was no enlargement of the breadth cultivated, and the price went up from 73.9 cents to 91.5. In 1874, the year following, the expansion exceeded two hundred thousand acres, producing no increase of aggregate product in that year of low yield, so that the price stood at 92.1, and a further enlargement of 200,000 acres followed, bringing the price down to 81.3 cents, which stopped the increase of area, while better crops and larger imports still farther reduced the price. The reduction of 4,000,000 last year sent up the price again from 66.6 to 82.3. The crop statement is as follows:

A noticeable fact in the local distribution of barley cultivation is the large proportion in three districts widely separated—California, New York, and Minnesota—which together produced 23,000,000 of the 41,000,000 bushels grown last year, and 25,000,000 of the 44,000,000 in the census year. In California its distribution is quite general—Alameda, Colusa, Monterey, San Joaquin, Santa Clara, and Sacramento being the counties of largest production, together supplying more than 5,000,000 of the 12,000,000 bushels produced in 1879. In New York, Ontario, Cayuga, Monroe, Yates, Niagara, and Wayne, in the wheat district of Western New York, are the principal factors in production, producing nearly half the crop of the State. In Wisconsin, Rock, Waukesha, Fond du Lac, Jefferson, Sheboygan, Walworth, Washington, and Milwaukee yield a large portion of the crop. In California it is used considerably for feeding, as it is in the East for drinking purposes. Very little is grown in the South.

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	26,718,500	1,177,666	$21,541,777	80.6	22.7	$18 30
1872	25,846,400	1,397,082	19,837,733	73.9	19.2	14 20
1873	32,044,491	1,387,106	29,333,529	91.5	23.1	21 15
1874	32,552,500	1,580,626	29,983,769	92.1	20.6	18 97
1875	36,908,600	1,789,902	29,952,082	81.3	20.6	16 73
1876	38,710,500	1,766,511	25,735,110	66.5	21.9	14 57
1877	34,441,400	1,614,654	22,028,044	64.0	21.3	13 64
1878	42,245,630	1,790,400	24,483,315	58.0	23.6	13 67
1879	40,283,100	1,680,700	23,714,444	58.9	24.0	14 11
1880	45,165,346	1,843,329	30,090,742	66.6	24.5	16 32
1881	41,161,330	1,967,510	33,862,513	82.3	20.9	17 21
Total	397,077,797	17,995,486	290,563,058	....	....	....
Annual average	36,097,962	1,635,953	26,414,823	73.2	22.0	16 14

RYE.

This crop shared in the disaster that overtook wheat in 1881, and made the lowest yield in ten years. Its average yield is greater than that of wheat, being nearly 14 bushels for a period of years throughout the country, while that of wheat slightly exceeds 12 bushels. Last year the estimated average was 11.6 bushels. The range of the general average is about 4 bushels, or from 11.6 to 15.9 during the past decade. Pennsylvania, Illinois, New York, Wisconsin, and Iowa are the principal factors in the supply of this cereal, producing nearly two-thirds. In the South its real prominence fails to appear in the census record, as it is far more used there for pasturage than for the grain, which is mainly used for seed. The following table is compiled from the records of estimates of this Department:

Calendar year.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	15, 365, 500	1, 069, 531	$12, 145, 646	79. 0	14. 2	$11 36
1872	14, 888, 600	1, 048, 654	11, 363, 693	76. 3	14. 1	10 83
1873	15, 142, 000	1, 150, 355	11, 548, 126	76. 2	13. 1	10 04
1874	14, 990, 900	1, 116, 716	12, 870, 411	85. 8	13. 4	11 52
1875	17, 722, 100	1, 359, 788	13, 631, 900	76. 9	13. 0	10 02
1876	20, 374, 800	1, 468, 374	13, 635, 826	66. 9	13. 8	9 28
1877	21, 170, 100	1, 412, 902	12, 542, 895	59. 2	14. 9	8 87
1878	25, 842, 790	1, 622, 700	13, 592, 826	52. 6	15. 9	8 38
1879	23, 639, 460	1, 625, 450	15, 507, 431	65. 6	14. 5	9 54
1880	24, 540, 829	1, 767, 619	18, 564, 560	75. 6	13. 9	10 50
1881	20, 704, 950	1, 789, 100	19, 827, 415	93. 3	11. 6	10 82
Total	214, 882, 029	15, 431, 189	154, 730, 729	....	....	....
Annual average	19, 489, 275	1, 402, 835	14, 066, 430	72. 2	13. 9	10 03

BUCKWHEAT.

This crop has a restricted range. It is annually grown to the extent of about 12,000,000 bushels, of which two-thirds are produced in New York and Pennsylvania, for consumption largely as breakfast-cakes in the great cities of the seaboard. A small quantity, however, is annually reported from nearly all the States. In the South its production is extremely limited—restricted to a few experimental patches. Its acreage has nearly doubled in ten years. The crop in 1881 was the smallest ever reported—11.4 bushels per acre. The range has been from this figure up to 20 bushels. The comparison of estimates of eleven years is as follows:

Calendar years.	Total production.	Total area of crop.	Total value of crop.	Average value per bushel.	Average yield per acre.	Average value of yield per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	8, 328, 700	413, 915	$6, 900, 268	82. 8	20. 1	$16 67
1872	8, 133, 500	448, 497	6, 747, 618	82. 9	18. 1	15 04
1873	7, 837, 700	454, 152	6, 382, 043	81. 4	17. 2	14 05
1874	8, 016, 600	452, 590	6, 477, 885	80. 8	17. 7	14 31
1875	10, 082, 100	575, 530	7, 166, 267	71. 0	17. 5	12 45
1876	9, 668, 800	666, 441	7, 021, 498	72. 6	14. 5	10 53
1877	10, 177, 000	649, 923	6, 998, 810	68. 7	15. 6	10 76
1878	12, 246, 820	673, 100	6, 454, 120	52. 7	18. 2	9 59
1879	13, 140, 000	639, 900	7, 856, 191	59. 8	20. 5	12 28
1880	14, 617, 535	822, 802	8, 682, 488	59. 4	17. 7	10 55
1881	9, 486, 200	828, 815	8, 205, 705	86. 5	11. 4	9 86
Total	111, 734, 955	6, 625, 665	78, 892, 893	....	....	....
Annual average	10, 157, 723	602, 333	7, 172, 081	70. 6	16. 1	11 87

POTATOES.

Never has there been so disastrous a season for potatoes at that of 1881. The range of estimated yields is from 53.5 bushels per acre in that year to 110.5 in 1875. The average for the period is placed at 84.2 bushels; so that but half a full crop was gathered; in some States scarcely a third of a crop, while a few had two-thirds of a full yield. The price was, of course, higher than ever before, 90.9 cents per bushel, at the date of returns of prices in December, and higher as consumption exhausted the partial supply. The lowest price during the period was 38.9 per bushel, in 1875, the average for eleven years 56.1. The loss of 70,000,000 bushels was severely felt, and could not be made good by importation. Though Irish and Scotch potatoes were sold in every market east and west, and the trade acknowledged to have attained extraordinary proportions, but 8,789,860 bushels were brought in at a cost of $4,660,120, against 2,170,372 bushels the previous year. Six-sevenths of the shortage was not made up, and there was a similar scarcity of root crops of all kinds.

Estimated annual product, acreage, and value of the potato crop of the United States from 1871 to 1881, inclusive.

Year.	Quantity.	Area.	Value.	Value per bushel.	Yield per acre.	Value per acre.
	Bushels.	*Acres.*		*Cents.*	*Bushels.*	
1871	120,461,100	1,220,912	$71,836,671	59.6	98.6	$58 83
1872	113,516,000	1,331,331	68,081,120	59.9	85.2	51 14
1873	106,089,000	1,295,139	74,774,890	70.5	81.9	57 74
1874	105,981,000	1,310,041	71,823,330	67.7	80.9	54 83
1875	166,877,000	1,510,041	65,019,420	38.9	110.5	43 06
1876	124,827,000	1,741,983	83,861,390	67.2	71.6	48 14
1877	170,092,000	1,792,287	76,249,500	44.8	94.9	42 54
1878	124,126,650	1,776,000	73,059,125	58.9	69.9	41 14
1879	181,626,400	1,836,800	79,153,673	43.6	98.9	43 09
1880	167,659,570	1,842,510	81,062,214	48.3	91.0	44 00
1881	109,145,494	2,041,670	99,291,341	90.9	53.5	48 63
Total	1,490,401,214	17,698,714	844,202,474			
Annual average	135,491,019	1,698,974	76,745,679	56.1	84.2	47 08

HAY.

The grass crop, green and dry, is worth more than any other in this country. The hay is worth far less than the pasturage in intrinsic value, and yet grass depastured produces an overwhelming proportion of the growth in flesh of all animals, and bears an important part in the fattening or furnishing of beeves. The following table presents the annual estimates of this Department of the product and value of the hay crop.

Estimated annual product, acreage, and value of the hay crop of the United States from 1871 to 1881, inclusive.

Years.	Quantity.	Area.	Value.	Value per ton.	Yield per acre.	Value per acre.
	Tons.	*Acres.*			*Tons.*	
1871	22,239,400	19,009,052	$351,717,035	$15 81	1.17	$18 50
1872	23,812,800	20,318,936	345,969,079	14 52	1.17	17 03
1873	25,085,100	21,894,084	339,895,486	13 55	1.14	15 52
1874	24,133,900	21,769,772	331,420,738	13 73	1.11	15 22
1875	27,873,600	23,507,964	342,203,445	12 27	1.18	14 56
1876	30,867,400	25,282,797	300,901,252	9 74	1.22	11 90
1877	31,629,300	25,367,708	271,934,950	8 59	1.24	10 72
1878	39,608,296	26,931,300	285,543,752	7 21	1.47	10 60
1879	35,493,000	27,484,991	330,804,494	9 32	1.29	12 04
1880	31,925,233	25,863,955	371,811,084	11 65	1.23	14 38
1881	35,135,064	30,888,700	415,131,366	13 43	1.14	13 43
Total	327,803,093	268,319,259	3,687,332,681	....	....	....
Annual average	29,800,281	24,392,660	335,212,062	11.25	1.22	13 74

CROP ESTIMATES FOR 1881.

Table showing the product of each principal crop of the several States named, the yield per acre, the total acreage, the average price in each State, and the value of each crop, for 1881.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MAINE.					
Indian corn....bushels..	1,064,000	34	31,300	$0 91	$968,240
Wheat....do....	617,000	14.1	43,700	1 56	962,520
Rye....do....	39,000	15	2,600	1 07	41,730
Oats....do....	2,369,000	28.9	82,100	52	1,231,880
Barley....do....	244,000	22	11,100	85	207,400
Buckwheat....do....	420,000	20.8	20,200	62	260,400
Potatoes....do....	3,342,248	52	64,274	77	2,573,531
Tobacco....pounds..	....	....	....	....	....
Hay....tons..	941,620	.86	1,094,907	12 10	11,393,602
Total....	....	....	1,850,181	....	17,639,302
NEW HAMPSHIRE.					
Indian corn....bushels..	1,262,000	34.2	36,900	87	1,097,940
Wheat....do....	175,000	15.2	11,500	1 56	273,000
Rye....do....	34,000	10.6	3,200	1 05	35,700
Oats....do....	1,030,000	34.7	29,700	52	535,600
Barley....do....	80,000	22.2	3,600	82	65,600
Buckwheat....do....	92,000	20	4,600	75	69,000
Potatoes....do....	1,831,158	63	29,066	80	1,464,926
Tobacco....pounds..	172,551	1,876	92	12	20,706
Hay....tons..	565,577	.90	628,419	11 75	6,645,530
Total....	....	....	747,077	....	10,208,002
VERMONT.					
Indian corn....bushels..	1,990,000	35.7	55,800	86	1,711,400
Wheat....do....	378,000	18	21,000	1 47	555,660
Rye....do....	104,000	16.8	6,200	1 02	106,080
Oats....do....	3,345,000	33.6	99,500	50	1,672,500
Barley....do....	285,000	25.4	11,200	87	247,950
Buckwheat....do....	341,000	20.1	17,000	72	245,520
Potatoes....do....	2,691,620	70	38,466	75	2,018,715
Tobacco....pounds..	132,736	1,562	85	15	19,910
Hay....tons..	1,030,159	1.10	936,508	11 20	11,537,781
Total....	....	....	1,186,759	....	18,115,516
MASSACHUSETTS.					
Indian corn....bushels..	1,406,000	25.1	56,000	88	1,237,280
Wheat....do....	19,000	15.8	1,200	1 50	28,500
Rye....do....	449,000	16.3	27,600	1 12	502,880
Oats....do....	703,000	30.4	23,100	65	456,950
Barley....do....	82,000	25.6	3,200	95	77,900
Buckwheat....do....	73,000	13.3	5,500	75	54,750
Potatoes....do....	1,814,230	55	32,986	1 00	1,814,230
Tobacco....pounds..	5,000,964	1,520	3,291	15	750,144
Hay....tons..	677,832	1.12	605,207	18 60	12,607,675
Total....	....	....	758,084	....	17,530,309
RHODE ISLAND.					
Indian corn....bushels..	327,000	27	12,100	90	294,300
Wheat....do....	260	10.4	25	1 50	390
Rye....do....	16,000	11.4	1,400	1 13	18,080
Oats....do....	164,000	29.3	5,600	67	109,880
Barley....do....	18,500	23.1	800	97	17,945
Buckwheat....do....	1,350	10.8	125	90	1,215
Potatoes....do....	362,880	60	6,048	1 00	362,880
Tobacco....pounds..	....	....	....	....	....
Hay....tons..	78,525	1.15	68,291	17 75	1,393,819
Total....	....	....	94,869	....	2,196,686

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
CONNECTICUT.					
Indian corn.................bushels..	1,427,000	25.5	55,900	$0 80	$1,141,600
Wheat.............................do....	39,000	17.7	2,200	1 42	55,380
Rye.................................do....	451,000	14.9	30,300	98	441,980
Oats................................do....	1,038,000	28.3	36,700	56	581,280
Barley.............................do....	12,300	19.8	620	1 00	12,300
Buckwheat......................do....	146,000	13	11,200	95	138,700
Potatoes.........................do....	2,083,315	65	32,051	1 02	2,124,981
Tobacco......................pounds..	13,763,759	1572	8,753	16	2,202,201
Hay.................................tons..	569,017	1.00	569,017	17 64	10,037,460
Total................................	....	....	746,741	....	16,735,882
NEW YORK.					
Indian corn.................bushels..	20,085,000	26.4	761,500	$0 77	$15,465,450
Wheat.............................do....	10,844,000	13.9	780,200	1 37	14,856,280
Rye.................................do....	2,820,000	12	234,600	93	2,622,600
Oats................................do....	38,160,000	28.8	1,324,700	48	18,316,800
Barley.............................do....	8,412,000	23.6	355,900	93	7,823,160
Buckwheat......................do....	3,338,000	11.9	279,600	82	2,737,160
Potatoes.........................do....	20,143,914	57	353,402	87	17,525,205
Tobacco......................pounds..	6,291,217	1249	5,037	14	880,770
Hay.................................tons..	5,502,591	1.12	4,913,028	14 55	80,062,699
Total................................	....	....	9,007,967	....	160,290,124
NEW JERSEY.					
Indian corn.................bushels..	7,829,000	23.2	336,800	77	6,028,330
Wheat.............................do....	2,018,000	12.7	158,700	1 43	2,885,740
Rye.................................do....	1,040,000	10.8	96,600	97	1,008,800
Oats................................do....	4,052,000	30.7	131,800	49	1,985,480
Barley.............................do....	4,200	16.8	250	97	4,074
Buckwheat......................do....	312,000	9	34,700	1 00	312,000
Potatoes.........................do....	2,400,960	60	40,016	1 04	2,496,998
Tobacco......................pounds..	181,689	1075	169	12	21,802
Hay.................................tons..	529,370	1.04	509,010	19 75	10,455,057
Total................................	....	....	1,308,045	....	25,198,281
PENNSYLVANIA.					
Indian corn.................bushels..	34,599,000	25.2	1,374,500	75	25,949,250
Wheat.............................do....	18,797,000	12.5	1,503,800	1 34	25,187,980
Rye.................................do....	4,050,000	10.5	386,600	96	3,888,000
Oats................................do....	38,579,000	31.8	1,212,700	48	18,517,920
Barley.............................do....	480,000	21.1	22,700	95	456,000
Buckwheat......................do....	2,466,000	10.1	244,000	96	2,367,360
Potatoes.........................do....	8,811,600	48.0	183,575	97	8,547,252
Tobacco......................pounds..	38,805,661	1173	33,080	13	5,044,735
Hay.................................tons..	2,924,120	1.10	2,658,291	13 53	39,563,344
Total................................	....	....	7,619,246	....	129,521,841
DELAWARE.					
Indian corn.................bushels..	2,940,000	14.4	204,100	60	1,764,000
Wheat.............................do....	1,044,000	10.1	102,900	1 40	1,461,600
Rye.................................do....	6,500	8.1	800	87	5,655
Oats................................do....	316,000	18.5	17,100	45	142,200
Barley.............................do....	....	....	....	....	....
Buckwheat......................do....	5,500	13.7	400	98	5,390
Potatoes.........................do....	172,903	43	4,021	1 00	172,903
Tobacco......................pounds..	....	....	....	....	....
Hay.................................tons..	49,136	1.02	48,173	17 70	869,707
Total................................	....	....	377,494	....	4,421,455
MARYLAND.					
Indian corn.................bushels..	16,277,000	24.2	671,400	64	10,417,280
Wheat.............................do....	7,213,000	11.7	618,300	1 35	9,737,550
Rye.................................do....	285,000	10.8	26,300	1 00	285,000
Oats................................do....	1,823,000	19.3	94,600	48	875,040
Barley.............................do....	6,200	25.8	240	1 10	6,820
Buckwheat......................do....	95,000	10	9,500	90	85,500
Potatoes.........................do....	959,905	47	20,415	1 03	988,702
Tobacco......................pounds..	25,869,218	676	38,265	08	2,069,537
Hay.................................tons..	272,402	.98	277,961	18 00	4,903,236
Total................................	....	....	1,756,981	....	29,368,665

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
VIRGINIA.					
Indian corn ....bushels..	27,200,000	15	1,809,200	$0 71	$19,312,000
Wheat ....do....	7,165,000	8	892,100	1 33	9,529,450
Rye ....do....	304,000	6.4	47,700	92	279,680
Oats ....do....	4,331,000	7.9	545,800	53	2,295,430
Barley ....do....	14,750	15.5	950	1 10	16,225
Buckwheat ....do....	153,000	9.7	15,800	73	111,690
Potatoes ....do....	1,348,280	40	33,707	86	1,159,520
Tobacco ....pounds..	77,649,854	556	139,663	08.6	2,677,907
Hay ....tons..	293,000	1.05	279,048	16 72	4,898,960
Total	....	....	3,763,938	....	44,280,863
NORTH CAROLINA.					
Indian corn ....bushels..	26,977,000	11.7	2,307,600	79	21,311,830
Wheat ....do....	4,579,000	6.9	662,200	1 49	6,822,710
Rye ....do....	376,000	6.2	60,600	97	364,720
Oats ....do....	4,081,000	8.1	506,800	62	2,530,220
Barley ....do....	2,500	10	250	1 15	2,875
Buckwheat ....do....	52,000	9.6	5,400	71	36,920
Potatoes ....do....	709,916	38	18,682	70	496,941
Tobacco ....pounds..	24,827,532	443	56,071	13.5	3,351,716
Hay ....tons..	90,900	1.15	79,043	15 80	1,436,220
Total	....	....	3,696,146	....	36,354,152
SOUTH CAROLINA.					
Indian corn ....bushels..	8,809,000	6.7	1,308,900	99	8,720,910
Wheat ....do....	988,000	5.7	173,900	1 65	1,630,200
Rye ....do....	32,000	4.5	7,100	1 60	51,200
Oats ....do....	3,098,000	11	281,900	97	3,005,060
Barley ....do....	16,850	14	1,200	1 20	20,220
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	98,460	30	3,282	71	69,907
Tobacco ....pounds..	47,528	248	192	14	6,653
Hay ....tons..	2,787	1.10	2,534	17 60	49,051
Total	....	....	1,779,008	....	13,553,201
GEORGIA.					
Indian corn ....bushels..	19,745,000	8.3	2,388,700	97	19,152,650
Wheat ....do....	2,933,000	6.1	477,200	1 63	4,780,790
Rye ....do....	144,000	6.6	21,900	1 40	201,600
Oats ....do....	5,566,000	9.1	612,300	87	4,842,420
Barley ....do....	22,000	14.7	1,500	1 25	27,500
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	294,245	35	8,407	60	176,547
Tobacco ....pounds..	242,758	242	1,004	14	33,986
Hay ....tons..	15,129	1.25	12,103	17 24	260,824
Total	....	....	3,523,114	....	29,476,317
FLORIDA.					
Indian corn ....bushels..	3,170,000	8.8	359,700	1 00	3,170,000
Wheat ....do....	480	5.1	95	1 65	792
Rye ....do....	3,200	4.9	650	1 60	5,120
Oats ....do....	392,000	8.2	47,800	92	360,640
Barley ....do....	....	....	....	....	....
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	59,040	40	1,476	55	32,472
Tobacco ....pounds..	23,085	216	107	20	4,617
Hay ....tons..	164	1.05	156	19 00	3,116
Total	....	....	409,984	....	3,576,757
ALABAMA.					
Indian corn ....bushels..	20,250,000	9.9	2,035,700	97	19,642,500
Wheat ....do....	1,479,000	6.6	222,500	1 58	2,336,820
Rye ....do....	31,000	5.7	5,400	1 43	44,330
Oats ....do....	3,073,000	9.1	337,200	89	2,734,970
Barley ....do....	5,780	9.6	600	1 37	7,919
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	366,864	45	7,643	90	330,178
Tobacco ....pounds..	466,133	221	2,110	18	83,903
Hay ....tons..	10,881	1.20	9,068	16 48	179,319
Total	....	....	2,620,221	....	25,359,039

Table showing the product of each principal crop, &c., for 1881—Continued.

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MISSISSIPPI.					
Indian corn ....bushels..	17,646,000	11	1,606,200	$0 96	$16,940,160
Wheat ....do....	197,000	5.6	34,900	1 60	315,200
Rye ....do....	5,250	6.2	850	1 40	7,350
Oats ....do....	2,185,000	10.3	211,700	85	1,857,250
Barley ....do....	....	....	....	....	....
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	298,320	40	7,458	92	274,454
Tobacco ....pounds..	436,010	287	1,519	17	74,121
Hay ....tons..	9,072	1.15	7,889	16 47	149,416
Total	....	....	1,870,516	....	19,617,951
LOUISIANA.					
Indian corn ....bushels..	9,693,000	13	745,600	98	9,499,140
Wheat ....do....	5,350	3.3	1,600	1 50	8,025
Rye ....do....	235,000	8.7	27,100	1 40	329,000
Oats ....do....	364,000	13.8	26,400	89	323,960
Barley ....do....	....	....	....	....	....
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	203,034	38	5,343	95	192,882
Tobacco ....pounds..	....	....	....	....	....
Hay ....tons..	35,178	1.10	31,980	16 20	569,884
Total	....	....	838,023	....	10,922,891
TEXAS.					
Indian corn ....bushels..	33,377,000	11.9	2,803,700	99	33,043,230
Wheat ....do....	3,339,000	12.7	263,200	1 40	4,674,600
Rye ....do....	42,000	14	3,000	1 20	50,400
Oats ....do....	8,324,000	26.8	311,100	61	5,077,640
Barley ....do....	106,000	19.3	5,500	90	95,400
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	277,440	40	6,936	98	271,891
Tobacco ....pounds..	217,950	304	716	18	39,231
Hay ....tons..	62,684	1.18	53,122	11 65	730,269
Total	....	....	3,447,274	....	43,982,661
ARKANSAS.					
Indian corn ....bushels..	21,028,000	14.8	1,425,600	94	19,766,320
Wheat ....do....	1,017,000	5.2	196,100	1 50	1,525,500
Rye ....do....	22,000	6.7	3,300	1 10	24,200
Oats ....do....	2,337,000	13.8	168,900	71	1,659,270
Barley ....do....	....	....	....	....	....
Buckwheat ....do....	....	....	....	....	....
Potatoes ....do....	440,484	44	10,011	99	436,079
Tobacco ....pounds..	979,922	484	2,023	08.4	82,313
Hay ....tons..	23,761	1.20	19,801	15 00	356,415
Total	....	....	1,825,735	....	23,850,097
TENNESSEE.					
Indian corn ....bushels..	36,232,000	12.4	2,915,300	72	26,087,040
Wheat ....do....	6,408,000	6.1	1,055,400	1 36	8,714,880
Rye ....do....	182,000	5.6	32,500	1 00	182,000
Oats ....do....	6,726,000	14.2	472,100	56	3,766,560
Barley ....do....	36,000	13.8	2,600	1 06	38,160
Buckwheat ....do....	43,000	8.3	5,200	84	36,120
Potatoes ....do....	1,394,447	43	32,429	80	1,115,558
Tobacco ....pounds..	22,157,300	550	40,286	07.6	1,683,954
Hay ....tons..	181,097	1.10	164,634	14 75	2,671,181
Total	....	....	4,720,449	....	44,295,453
WEST VIRGINIA.					
Indian corn ....bushels:	12,980,000	22.7	571,100	74	9,605,200
Wheat ....do....	4,413,000	10.5	420,600	1 25	5,516,250
Rye ....do....	165,000	9.8	16,900	96	158,400
Oats ....do....	2,098,000	16.8	124,800	47	986,060
Barley ....do....	10,250	20.5	500	90	9,225
Buckwheat ....do....	325,000	10.3	31,500	81	263,250
Potatoes ....do....	1,062,720	45	23,616	99	1,052,093
Tobacco ....pounds..	2,068,531	503	4,112	08.5	175,825
Hay ....tons..	236,985	1.06	223,571	12 85	3,045,257
Total	....	....	1,416,699	....	20,811,[illegible]

Table showing the product of each principal crop, &c., for 1881—**Continued.**

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
KENTUCKY.					
Indian corn....bushels..	51, 624, 000	17	3, 042, 400	$0 70	$36, 136, 800
Wheat....do....	8, 625, 000	7. 5	1, 156, 600	1 31	11, 298, 750
Rye....do....	694, 000	11. 1	62, 300	99	687, 060
Oats....do....	6, 534, 000	16. 3	400, 500	47	3, 070, 980
Barley....do....	344, 000	17	20, 200	89	306, 160
Buckwheat....do....	10, 500	9. 5	1, 100	74	7, 770
Potatoes....do....	1, 602, 808	37	43, 319	1 00	1, 602, 808
Tobacco....pounds..	163, 037, 700	700	232, 911	08. 8	14, 347, 316
Hay....tons..	220, 926	1. 20	184, 105	13 00	2, 872, 038
Total....	....	....	5, 144, 435	....	70, 230, 177
OHIO.					
Indian corn....bushels..	79, 760, 000	25. 4	3, 134, 400	61	48, 653, 600
Wheat....do....	38, 520, 000	13. 3	2, 902, 100	1 29	49, 690, 800
Rye....do....	392, 000	13. 1	29, 900	92	360, 640
Oats....do....	25, 009, 000	27. 7	902, 300	44	11, 003, 960
Barley....do....	1, 122, 000	16. 4	68, 300	99	1, 110, 780
Buckwheat....do....	183, 000	8. 4	21, 900	96	175, 680
Potatoes....do....	4, 674, 459	31	150, 789	1 10	5, 141, 905
Tobacco....pounds..	35, 419, 913	964	36, 760	08	2, 833, 593
Hay....tons..	2, 255, 141	1. 05	2, 147, 753	12 90	29, 091, 319
Total....	....	....	9, 394, 202	....	148, 062, 277
MICHIGAN.					
Indian corn....bushels..	25, 068, 000	28	894, 000	63	15, 792, 840
Wheat....do....	21, 220, 000	10. 9	1, 950, 300	1 25	26, 525, 000
Rye....do....	271, 000	12. 5	21, 700	91	246, 610
Oats....do....	18, 057, 000	32. 7	552, 600	46	8, 306, 220
Barley....do....	1, 249, 000	24. 3	51, 500	93	1, 161, 570
Buckwheat....do....	468, 000	14. 5	32, 200	90	421, 200
Potatoes....do....	7, 632, 162	58	131, 589	80	6, 105, 730
Tobacco....pounds..	87, 706	498	176	12. 5	10, 963
Hay....tons..	1, 324, 194	1. 15	1, 151, 473	13 15	17, 413, 151
Total....	....	....	4, 785, 538	....	75, 983, 284
INDIANA.					
Indian corn....bushels..	79, 618, 000	21. 8	3, 657, 800	60	47, 770, 800
Wheat....do....	31, 353, 000	10. 8	2, 903, 100	1 27	39, 818, 310
Rye....do....	249, 000	10. 2	24, 400	93	231, 570
Oats....do....	15, 711, 000	23	683, 000	42	6, 598, 620
Barley....do....	385, 000	26	14, 800	1 05	404, 250
Buckwheat....do....	79, 000	11	7, 200	99	78, 210
Potatoes....do....	2, 961, 910	35	84, 626	1 06	3, 139, 625
Tobacco....pounds..	7, 719, 373	717	10, 760	07. 5	578, 953
Hay....tons..	1, 374, 694	1. 20	1, 145, 578	12 20	16, 771, 267
Total....	....	....	8, 531, 264	....	115, 397, 604
ILLINOIS.					
Indian corn....bushels..	176, 733, 000	19. 4	9, 096, 600	58	102, 505, 140
Wheat....do....	26, 822, 000	8. 2	3, 285, 200	1 22	32, 722, 840
Rye....do....	2, 775, 000	15. 5	179, 300	91	2, 525, 250
Oats....do....	66, 094, 000	33. 4	1, 979, 400	43	28, 420, 420
Barley....do....	754, 000	15. 5	48, 800	86	648, 440
Buckwheat....do....	148, 000	7. 6	19, 500	99	146, 520
Potatoes....do....	6, 322, 464	48	131, 718	1 05	6, 638, 587
Tobacco....pounds..	3, 346, 195	661	5, 062	08. 2	274, 387
Hay....tons..	3, 214, 713	1. 30	2, 472, 856	11 40	36, 647, 728
Total....	....	....	17, 218, 436	....	210, 529, 312
WISCONSIN.					
Indian corn....bushels..	29, 040, 000	27. 6	1, 054, 000	54	15, 681, 600
Wheat....do....	17, 987, 000	11. 3	1, 595, 300	1 19	21, 404, 530
Rye....do....	2, 353, 000	14. 3	164, 500	90	2, 117, 700
Oats....do....	31, 204, 000	28. 6	1, 092, 200	40	12, 481, 600
Barley....do....	5, 296, 000	24. 5	215, 800	84	4, 448, 640
Buckwheat....do....	386, 000	12	32, 200	84	324, 240
Potatoes....do....	7, 221, 600	75	94, 288	84	6, 066, 144
Tobacco....pounds..	8, 702, 770	866	10, 045	12. 5	1, 087, 846
Hay....tons..	1, 877, 989	1. 15	1, 633, 034	10 82	20, 319, 841
Total....	....	....	5, 893, 367	....	83, 952, 141

Table showing the product of each principal crop, &c., for 1881—Continued

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MINNESOTA.					
Indian corn........bushels..	16,252,000	32	508,500	$0 53	$8,613,560
Wheat........do....	35,952,000	11.4	3,152,100	1 06	38,109,120
Rye........do....	193,000	14.7	13,100	74	142,820
Oats........do....	23,760,000	35.6	667,700	43	10,216,800
Barley........do....	4,145,000	32.5	127,700	71	2,942,950
Buckwheat........do....	46,000	12.4	3,700	83	38,180
Potatoes........do....	5,031,390	95	52,962	65	3,270,403
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	1,587,805	1.18	1,345,597	7 15	11,352,806
Total........	....	....	5,871,359	....	74,686,639
IOWA.					
Indian corn........bushels..	173,289,000	25.8	6,710,200.	44	76,247,160
Wheat........do....	18,248,000	6.6	2,775,500	1 06	19,342,880
Rye........do....	1,242,000	11.4	109,200	80	993,600
Oats........do....	42,434,000	26.2	1,618,700	34	14,427,560
Barley........do....	3,498,000	20.8	167,800	74	2,588,520
Buckwheat........do....	167,000	12	13,900	93	155,310
Potatoes........do....	6,541,150	55	118,930	1 02	6,671,973
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	3,541,662	1.25	2,833,330	6 63	23,481,219
Total........	....	....	14,347,560	....	143,908,222
MISSOURI.					
Indian corn........bushels..	93,069,000	16.5	5,650,100	65	60,494,850
Wheat........do....	20,399,000	8.6	2,382,700	1 19	24,274,810
Rye........do....	458,000	11.8	38,900	85	389,300
Oats........do....	22,783,000	23.8	959,200	45	10,252,350
Barley........do....	101,000	15.8	6,400	98	98,980
Buckwheat........do....	66,000	12.5	5,300	98	64,680
Potatoes........do....	2,662,881	39	68,279	1 12	2,982,427
Tobacco........pounds..	12,233,959	877	13,950	08.3	1,015,418
Hay........tons..	1,066,683	1.10	969,712	12 50	13,333,537
Total........	....	....	10,094,541	....	112,906,352
KANSAS.					
Indian corn........bushels..	76,377,000	18.2	4,196,500	58	44,298,660
Wheat........do....	19,909,000	9.1	2,198,000	1 05	20,904,450
Rye........do....	467,000	12.2	38,200	74	345,580
Oats........do....	8,754,000	19.8	441,700	40	3,501,600
Barley........do....	243,000	12.3	19,700	75	182,250
Buckwheat........do....	40,000	9.5	4,200	99	39,600
Potatoes........do....	2,627,586	38	69,147	1 30	3,415,862
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	1,558,344	1.08	1,442,911	5 40	8,415,058
Total........	....	....	8,410,358	....	81,103,060
NEBRASKA.					
Indian corn........bushels..	58,913,000	27.4	2,149,200	39	22,976,070
Wheat........do....	13,840,000	7.1	1,958,500	97	13,424,800
Rye........do....	424,000	11.1	38,200	71	301,040
Oats........do....	6,976,000	21.4	325,300	37	2,581,120
Barley........do....	1,270,000	8.9	142,200	55	698,500
Buckwheat........do....	17,000	8.1	2,100	97	16,490
Potatoes........do....	1,496,736	48	31,182	98	1,466,801
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	801,142	1.20	667,618	4 50	3,605,139
Total........	....	....	5,314,300	....	45,069,960
CALIFORNIA.					
Indian corn........bushels..	2,633,000	27.2	96,700	78	2,053,740
Wheat........do....	31,406,000	12	2,367,200	1 03	32,348,180
Rye........do....	209,000	11.1	18,800	1 00	209,000
Oats........do....	1,548,000	23.1	67,100	60	928,800
Barley........do....	10,146,000	18.9	537.000	77	7,812,420
Buckwheat........do....	6,100	17.9	340	1 00	6,100
Potatoes........do ...	4,479,245	85	52,697	80	3,583,396
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	1,078,421	1,35	798,830	12 20	13,156,736
Total........	....	....	3,938,660	....	60,098,372

Table showing the product of each principal crop, &c., for 1881—**Continued.**

Products.	Quantity produced in 1881.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
OREGON.					
Indian corn.....bushels..	101,000	20.2	5,000	$0 75	$75,7[illegible]
Wheat.....do....	12,673,000	17.2	738,600	88	11,152,[illegible]
Rye.....do....	18,000	20	900	67	12,[illegible]
Oats.....do....	5,278,000	34.6	152,400	43	2,2[illegible]
Barley.....do....	745,000	25.7	29,000	58	432,[illegible]
Buckwheat.....do....	6,750	15	450	1 00	6,7[illegible]
Potatoes.....do....	1,238,895	115	10,773	50	61[illegible]
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	271,511	1 40	193,936	12 08	3,27[illegible]
Total.....	.....	.....	1,131,059	.....	17,[illegible]
NEVADA.					
Indian corn.....bushels..	13,000	24.8	525	1 00	13,[illegible]
Wheat.....do....	48,000	14.5	3,300	1 20	57,[illegible]
Rye.....do....	.....	.....	.....	.....	.....
Oats.....do....	190,000	31.7	6,000	90	171,[illegible]
Barley.....do....	450,000	21.4	21,000	1 20	540,[illegible]
Buckwheat.....do....	.....	.....	.....	.....	.....
Potatoes.....do....	294,300	90	3,270	1 35	397,[illegible]
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	98,729	1 30	75,945	15 00	1,480,[illegible]
Total.....	.....	.....	110,040	.....	2,659,[illegible]
COLORADO.					
Indian corn.....bushels..	352,000	25.5	13,800	1 05	369,6[illegible]
Wheat.....do....	1,310,000	19.8	66,000	1 33	1,742,3[illegible]
Rye.....do....	28,000	20	1,400	97	27,1[illegible]
Oats.....do....	771,000	27.4	28,100	81	624,5[illegible]
Barley.....do....	88,000	18	4,900	1 15	101,2[illegible]
Buckwheat.....do....	.....	.....	.....	.....	.....
Potatoes.....do....	428,560	80	5,357	1 30	557,1[illegible]
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	85,913	1.20	71,594	20 00	1,71[illegible]
Total.....	.....	.....	191,151	.....	5,140,15[illegible]
TERRITORIES.					
Indian corn.....bushels..	5,761,000	32.2	178,700	95	5,472,9[illegible]
Wheat.....do....	11,300,000	17.9	631,200	1 08	12,204,[illegible]
Rye.....do....	96,000	18.8	5,100	87	83,5[illegible]
Oats.....do....	7,224,000	28.7	251,500	62	4,47[illegible]
Barley.....do....	1,487,000	21.3	69,700	84	1,24[illegible]
Buckwheat.....do....	.....	.....	.....	.....	.....
Potatoes.....do....	2,761,870	101	27,434	70	1,93[illegible]
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	675,209	1.20	562,667	12 40	8,372,4[illegible]
Total.....	.....	.....	1,726,301	.....	33,793,[illegible]

Summary for each State, showing the product, the area, and the value of each crop for 1881.

STATES.	CORN.			WHEAT.			RYE.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	1,064,000	31,300	$968,240	617,000	43,700	$962,520	39,000	2,600	$41,730
New Hampshire	1,262,000	36,900	1,097,940	175,000	11,500	273,000	34,000	3,200	35,700
Vermont	1,990,000	55,800	1,711,400	378,000	21,000	555,660	104,000	6,200	106,080
Massachusetts	1,406,000	56,000	1,237,280	19,000	1,200	28,500	449,000	27,600	502,880
Rhode Island	327,000	12,100	294,300	260	25	390	16,000	1,400	18,080
Connecticut	1,427,000	55,900	1,141,600	39,000	2,200	55,380	451,000	30,300	441,980
New York	20,085,000	761,500	15,465,450	10,844,000	780,200	14,856,280	2,820,000	234,600	2,622,600
New Jersey	7,829,000	336,800	6,028,330	2,018,000	158,700	2,885,740	1,040,000	96,600	1,008,800
Pennsylvania	34,599,000	1,374,500	25,949,250	18,797,000	1,508,800	25,187,980	4,050,000	386,600	3,888,000
Delaware	2,940,000	204,100	1,764,000	1,044,000	102,900	1,461,600	6,500	800	5,655
Maryland	16,277,000	671,400	10,417,280	7,213,000	618,800	9,737,550	285,000	26,300	285,000
Virginia	27,200,000	1,809,200	19,312,000	7,165,000	892,100	9,529,450	304,000	47,700	279,680
North Carolina	26,977,000	2,307,600	21,311,830	4,579,000	662,200	6,822,710	376,000	60,600	364,720
South Carolina	8,809,000	1,308,900	8,720,910	988,000	173,900	1,630,200	32,000	7,100	51,200
Georgia	19,745,000	2,388,700	19,152,650	2,933,000	477,200	4,780,790	144,000	21,900	201,600
Florida	3,170,000	359,700	3,170,000	480	95	792	3,200	650	5,120
Alabama	20,250,000	2,035,700	19,642,500	1,479,000	222,500	2,336,820	31,000	5,400	44,330
Mississippi	17,646,000	1,606,200	16,940,160	197,000	34,900	315,200	5,250	850	7,350
Louisiana	9,698,000	745,600	9,499,140	5,350	1,600	8,025	235,000	27,100	329,000
Texas	33,377,000	2,803,700	33,043,230	3,339,000	263,200	4,674,600	42,000	3,000	50,400
Arkansas	21,028,000	1,425,600	19,766,320	1,017,000	196,100	1,525,500	22,000	3,300	24,200
Tennessee	36,232,000	2,915,300	26,087,040	6,408,000	1,055,400	8,714,880	182,000	22,500	182,000
West Virginia	12,980,000	571,100	9,605,200	4,413,000	420,600	5,516,250	165,000	16,900	158,400
Kentucky	51,624,000	3,042,400	36,136,800	8,625,000	1,156,600	11,298,750	694,000	62,300	687,060
Ohio	79,760,000	3,184,400	48,653,600	38,590,000	2,902,100	49,690,800	392,000	29,900	360,640
Michigan	25,068,000	894,000	15,792,840	21,220,000	1,950,800	26,525,000	271,000	21,700	246,610
Indiana	79,618,000	3,657,800	47,770,800	31,353,000	2,903,100	39,818,310	249,000	24,400	231,570
Illinois	176,733,000	9,096,600	102,505,140	26,822,000	3,285,200	32,722,840	2,775,000	179,300	2,525,250
Wisconsin	29,040,000	1,054,000	15,681,600	17,987,000	1,595,800	21,404,530	2,353,000	164,500	2,117,700
Minnesota	16,252,000	508,500	8,618,560	35,952,000	3,152,100	38,109,120	193,000	13,100	142,820
Iowa	173,289,000	6,710,200	76,247,160	18,248,000	2,775,500	19,342,880	1,242,000	109,200	993,600
Missouri	93,069,000	5,650,100	60,494,850	20,399,000	2,382,700	24,274,810	458,000	38,900	389,300
Kansas	76,377,000	4,196,500	44,298,660	19,909,000	2,198,000	20,904,450	467,000	38,200	345,580
Nebraska	58,913,000	2,149,200	22,976,070	13,840,000	1,958,500	13,424,800	424,000	38,200	301,040
California	2,633,000	96,700	2,053,740	31,406,000	2,367,200	32,348,180	209,000	13,800	209,000
Oregon	101,000	5,000	75,750	12,673,000	738,600	11,152,240	18,000	900	12,060
Nevada	18,000	525	13,000	48,000	3,300	57,600	....	....	....
Colorado	352,000	13,800	369,600	1,310,000	66,000	1,742,300	28,000	1,400	27,160
Territories	5,761,000	178,700	5,472,950	11,300,000	631,200	12,204,000	96,000	5,100	83,520
Total	1,194,916,000	64,262,025	759,482,170	383,280,090	37,709,020	456,880,427	20,704,950	1,789,100	19,327,415

Summary for each State, showing the product, the area, and the value of each crop for 1881—Continued.

STATES.	OATS.			BARLEY.			BUCKWHEAT.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	2,369,000	82,100	$1,231,880	244,000	11,100	$207,400	420,000	20,200	$260,400
New Hampshire	1,030,000	29,700	535,600	80,000	3,600	65,600	92,000	4,600	69,000
Vermont	3,345,000	99,500	1,672,500	285,000	11,200	247,950	341,000	17,000	245,520
Massachusetts	703,000	23,100	456,950	82,000	3,200	77,900	73,000	5,500	54,750
Rhode Island	164,000	5,600	109,880	18,500	800	17,945	1,350	125	1,215
Connecticut	1,038,000	36,700	581,280	12,300	620	12,300	146,000	11,200	138,700
New York	38,166,000	1,324,700	18,316,800	8,412,000	355,900	7,823,160	3,338,000	279,600	2,737,160
New Jersey	4,052,000	131,800	1,985,480	4,200	250	4,074	312,000	34,700	312,000
Pennsylvania	38,579,000	1,212,700	18,517,920	480,000	22,700	456,000	2,466,000	244,000	2,367,360
Delaware	316,000	17,100	142,200	....	....	....	5,500	400	5,390
Maryland	1,823,000	94,600	875,040	6,200	240	6,820	95,000	9,500	85,500
Virginia	4,331,000	545,800	2,295,430	14,750	950	16,225	153,000	15,800	111,690
North Carolina	4,081,000	506,300	2,530,220	2,500	250	2,875	52,000	5,400	36,920
South Carolina	3,098,000	281,900	3,005,060	16,850	1,200	20,220	....	....	....
Georgia	5,566,000	612,300	4,842,420	22,000	1,500	27,500	....	....	....
Florida	392,000	47,800	360,640	....	....	....	....	....	....
Alabama	3,073,000	337,200	2,734,970	5,780	600	7,919	....	....	....
Mississippi	2,185,000	211,700	1,857,250	....	....	....	....	....	....
Louisiana	364,000	26,400	323,960	....	....	....	....	....	....
Texas	8,324,000	311,100	5,077,640	106,000	5,500	95,400	....	....	....
Arkansas	2,337,000	168,900	1,659,270	....	....	....	....	....	....
Tennessee	6,726,000	472,100	3,766,560	36,000	2,600	38,160	43,000	5,200	36,120
West Virginia	2,098,000	124,800	986,060	10,250	500	9,225	325,000	31,500	263,250
Kentucky	6,534,000	400,500	3,070,980	344,000	20,200	306,160	10,500	1,100	7,770
Ohio	25,009,000	902,300	11,003,960	1,122,000	68,300	1,110,780	183,000	21,900	175,680
Michigan	18,057,000	552,600	8,306,220	1,249,000	51,500	1,161,570	468,000	32,200	421,250
Indiana	15,711,000	683,000	6,598,620	385,000	14,800	404,250	79,000	7,200	78,210
Illinois	66,094,000	1,979,400	28,420,420	754,000	48,800	648,440	148,000	19,500	146,520
Wisconsin	31,204,000	1,092,200	12,481,600	5,296,000	215,800	4,448,640	356,000	32,200	324,240
Minnesota	23,760,000	667,700	10,216,800	4,145,000	137,700	2,942,950	46,000	3,700	38,180
Iowa	42,434,000	1,618,700	14,427,560	3,498,000	167,800	2,598,520	167,000	13,900	155,310
Missouri	22,788,000	959,200	10,252,850	101,000	6,400	98,980	66,000	5,300	64,680
Kansas	8,754,000	441,700	3,501,600	243,000	19,700	182,250	40,000	4,200	39,600
Nebraska	6,976,000	325,300	2,581,120	1,270,000	142,200	698,500	17,000	2,100	16,490
California	1,548,000	67,100	928,800	10,146,000	537,000	7,812,420	6,100	840	6,100
Oregon	5,278,000	152,400	2,269,540	745,000	29,000	432,100	6,750	450	6,750
Nevada	190,000	6,000	171,000	450,000	21,000	540,000	....	....	....
Colorado	771,000	38,100	624,510	88,000	4,900	101,200	....	....	....
Territories	7,224,000	251,500	4,478,880	1,487,000	69,700	1,249,080	....	....	....
Total	416,481,000	16,831,600	193,198,970	41,161,330	1,967,510	23,662,513	9,486,200	828,815	8,205,705

Summary for each State, showing the product, the area, and the value of each crop for 1881—Continued.

STATES.	POTATOES.			TOBACCO.			HAY.		
	Bushels.	Acres.	Value.	Pounds.	Acres.	Value.	Tons.	Acres.	Value.
Maine	3, 342, 248	64, 274	$2, 573, 531	....	....	....	941, 620	1, 094, 907	$11, 393, 602
New Hampshire	1, 831, 158	29, 066	1, 464, 926	172, 551	92	$20, 706	565, 577	628, 419	6, 645, 530
Vermont	2, 691, 620	38, 466	2, 018, 715	132, 736	85	19, 910	1, 030, 159	936, 508	11, 537, 781
Massachusetts	1, 814, 230	32, 986	1, 814, 230	5, 000, 964	3, 291	750, 144	677, 832	605, 207	12, 607, 675
Rhode Island	362, 880	6, 048	362, 880	....	....	....	78, 535	68, 291	1, 393, 996
Connecticut	2, 083, 315	32, 051	2, 124, 981	13, 763, 759	8, 753	2, 202, 201	569, 017	560, 617	10, 037, 460
New York	20, 143, 914	353, 402	17, 525, 205	6, 291, 217	5, 037	880, 770	5, 502, 591	4, 913, 028	80, 062, 699
New Jersey	2, 400, 960	40, 016	2, 496, 998	181, 689	169	21, 802	529, 370	509, 010	10, 455, 057
Pennsylvania	8, 811, 600	183, 575	8, 547, 252	38, 805, 661	33, 080	5, 044, 735	2, 924, 120	2, 658, 291	39, 563, 344
Delaware	172, 908	4, 021	172, 903	....	....	....	49, 136	48, 173	869, 767
Maryland	959, 905	20, 415	988, 702	25, 869, 218	38, 265	2, 069, 537	272, 402	277, 961	4, 903, 236
Virginia	1, 348, 280	33, 707	1, 159, 520	77, 649, 854	139, 663	6, 677, 907	293, 400	279, 048	4, 898, 960
North Carolina	709, 916	18, 682	496, 941	24, 827, 532	56, 071	3, 351, 716	90, 900	79, 043	1, 436, 220
South Carolina	98, 400	3, 282	69, 907	47, 528	192	6, 653	2, 787	2, 534	49, 051
Georgia	294, 245	8, 407	176, 547	242, 758	1, 004	33, 986	15, 129	12, 103	260, 824
Florida	59, 040	1, 476	32, 472	23, 085	107	4, 617	164	156	3, 116
Alabama	366, 864	7, 643	330, 178	466, 133	2, 110	83, 903	10, 881	9, 068	179, 819
Mississippi	298, 330	7, 458	274, 454	[illegible] 010	1, 519	74, 121	9, 072	7, 889	149, 416
Louisiana	203, 034	5, 348	192, 882	....	....	....	35, 178	31, 980	569, 884
Texas	277, 440	6, 936	271, 891	217, 950	716	39, 231	62, 684	53, 122	730, 209
Arkansas	440, 484	10, 011	436, 079	979, 922	2, 023	82, 313	23, 761	19, 801	356, 415
Tennessee	1, 394, 447	32, 429	1, 115, 558	22, 157, 300	40, 286	1, 683, 954	181, 097	164, 634	2, 671, 181
West Virginia	1, 062, 720	23, 616	1, 052, 093	2, 066, 531	4, 112	175, 655	236, 985	223, 571	3, 045, 257
Kentucky	1, 602, 803	43, 319	1, 602, 803	163, 037, 700	232, 911	14, 347, 316	220, 926	184, 105	2, 872, 036
Ohio	4, 674, 459	150, 789	5, 141, 905	35, 419, 918	36, 760	2, 833, 593	2, 255, 141	2, 147, 753	29, 091, 819
Michigan	7, 632, 162	131, 589	6, 105, 730	87, 706	176	10, 963	1, 324, 194	1, 151, 478	17, 418, 151
Indiana	2, 961, 910	84, 626	3, 139, 625	7, 719, 373	10, 760	578, 952	1, 374, 694	1, 145, 578	16, 771, 267
Illinois	6, 322, 464	131, 718	6, 638, 587	3, 346, 195	5, 062	274, 387	3, 214, 713	2, 472, 856	36, 647, 798
Wisconsin	7, 221, 600	96, 288	6, 066, 144	8, 702, 770	10, 045	1, 087, 846	1, 877, 989	1, 633, 034	20, 319, 841
Minnesota	5, 031, 390	52, 962	3, 270, 403	....	....	....	1, 587, 805	1, 345, 507	11, 352, 806
Iowa	6, 541, 150	118, 930	6, 671, 973	....	....	....	3, 541, 662	2, 833, 830	23, 481, 219
Missouri	2, 662, 881	68, 279	2, 982, 427	12, 233, 959	13, 950	1, 015, 418	1, 066, 683	969, 712	13, 333, 537
Kansas	2, 627, 586	69, 147	3, 415, 862	....	....	....	1, 558, 344	1, 442, 911	8, 415, 058
Nebraska	1, 496, 736	31, 182	1, 466, 801	....	....	....	801, 142	667, 618	3, 605, 139
California	4, 479, 245	52, 697	3, 583, 396	....	....	....	1, 078, 421	798, 830	13, 156, 736
Oregon	1, 238, 895	10, 778	619, 448	....	....	....	271, 511	193, 986	3, 279, 853
Nevada	294, 300	3, 270	397, 305	....	....	....	98, 729	75, 945	1, 480, 935
Colorado	428, 560	5, 357	557, 128	....	....	....	85, 913	71, 594	1, 718, 260
Territories	2, 761, 370	27, 434	1, 932, 959	....	....	....	675, 200	562, 667	8, 372, 480
Total	109, 145, 494	2, 041, 670	99, 291, 341	449, 880, 014	646, 239	43, 372, 336	35, 135, 064	30, 888, 700	415, 131, 366

Table showing the average yield per acre and the price per bushel, pound, or ton of farm products for the year 1881.

STATES.	CORN.		WHEAT.		RYE.		OATS.		BARLEY.		BUCKWHEAT.		POTATOES.		TOBACCO.		HAY.	
	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Pounds.	Price per pound.	Tons.	Price per ton.
																Cts.		
Maine	34.0	$0 91	14.1	$1 56	15.0	$1 07	28.9	$0 52	22.0	$0 85	20.8	$0 62	52	$0 77	....	......	86	$12 10
New Hampshire	34.2	87	15.3	1 56	10.6	1 05	34.7	52	22.2	82	20.0	75	63	80	1,876	12	90	11 75
Vermont	35.7	86	18.0	1 47	16.8	1 02	33.6	50	25.4	87	20.1	72	70	75	1,562	15	1.10	11 20
Massachusetts	25.1	88	15.8	1 50	16.8	1 12	30.4	65	25.6	95	13.3	75	55	1 00	1,520	15	1.12	18 60
Rhode Island	27.0	90	10.4	1 50	11.4	1 13	29.3	67	23.1	97	10.8	90	60	1 00	....	......	1.15	17 75
Connecticut	25.5	80	17.7	1 42	14.9	98	28.3	56	19.8	1 00	18.0	95	65	1 02	1,572	16	1.00	17 64
New York	26.4	77	13.9	1 37	12.0	93	28.8	48	23.6	93	11.9	82	57	87	1,249	14	1.12	14 55
New Jersey	23.2	77	12.7	1 43	10.8	97	30.7	49	16.8	97	9.0	1 00	60	1 04	1,075	12	1.04	19 75
Pennsylvania	25.2	75	12.5	1 34	10.5	96	31.8	48	21.1	95	10.1	96	48	97	1,178	13	1.10	13 58
Delaware	14.4	60	10.1	1 40	8.1	87	18.5	45	......	......	13.7	98	43	1 00	....	......	1.02	17 70
Maryland	24.2	64	11.7	1 35	10.8	1 00	19.8	48	25.8	1 10	10.0	90	47	1 08	676	8	98	18 00
Virginia	15.0	71	8.0	1 33	6.4	92	7.9	58	15.5	1 10	9.7	78	40	86	556	8.6	1.05	16 73
North Carolina	11.7	79	6.9	1 49	6.2	97	8.1	62	10.0	1 15	9.6	71	38	70	443	13.5	1.15	15 80
South Carolina	6.7	90	5.7	1 65	4.5	1 60	11.0	97	14.0	1 20	......	......	30	71	248	14	1.10	17 60
Georgia	8.3	97	6.1	1 63	6.6	1 40	9.1	87	14.7	1 25	......	......	35	60	242	14	1.25	17 24
Florida	8.8	1 00	5.1	1 65	4.9	1 60	8.2	92	......	......	......	......	40	55	216	20	1.05	19 00
Alabama	9.9	97	6.6	1 58	5.7	1 43	9.1	89	9.6	1 37	......	......	48	90	221	18	1.20	16 48
Mississippi	11.0	96	5.6	1 60	6.2	1 40	10.3	85	......	......	......	......	40	92	287	17	1.15	16 47
Louisiana	13.0	98	3.3	1 50	8.7	1 40	13.8	89	......	......	......	......	38	95	....	......	1.10	16 20
Texas	11.9	99	12.7	1 40	14.0	1 20	26.8	61	19.3	90	......	......	40	98	304	18	1.18	11 65
Arkansas	14.8	94	5.2	1 50	6.7	1 10	13.8	71	......	......	......	......	44	99	484	8.4	1.20	15 00
Tennessee	12.4	72	6.1	1 36	5.6	1 00	14.2	56	12.8	1 06	8.3	84	43	80	550	7.6	1.10	14 75
West Virginia	22.7	74	10.5	1 25	9.8	96	16.8	47	20.5	90	10.3	81	45	99	503	8.5	1.06	12 85
Kentucky	17.0	70	7.5	1 31	11.1	99	16.3	47	17.0	89	9.5	74	37	1 00	700	8.8	1.20	18 00
Ohio	25.4	61	13.3	1 29	13.1	92	27.7	44	16.4	99	8.4	96	31	1 10	964	8	1.05	12 90
Michigan	28.0	63	10.9	1 26	12.5	91	32.7	46	24.3	98	14.5	90	58	80	498	12.5	1.15	13 15
Indiana	21.8	60	10.8	1 27	10.2	93	23.0	42	26.0	1 05	11.0	99	35	1 06	717	7.5	1.20	12 20
Illinois	19.4	58	8.2	1 22	15.5	91	33.4	43	15.5	86	7.6	99	48	1 05	661	8.2	1.30	11 40
Wisconsin	27.6	54	11.3	1 19	14.3	90	28.6	40	24.5	84	12.0	84	75	84	866	12.5	1.15	10 82
Minnesota	32.0	53	11.4	1 06	14.7	74	35.6	43	32.5	71	12.4	83	95	65	....	......	1.18	7 15
Iowa	35.8	44	6.6	1 06	11.4	80	26.2	34	20.8	74	12.0	93	55	1 02	....	......	1.25	6 63
Missouri	16.5	65	8.6	1 19	11.8	85	23.8	45	15.8	96	12.5	98	39	1 12	877	8.3	1.10	12 50
Kansas	18.2	58	9.1	1 05	12.2	74	19.8	40	12.3	75	9.5	99	38	1 30	....	......	1.08	5 40
Nebraska	27.4	39	7.1	97	11.1	71	21.4	37	8.9	55	8.1	97	48	98	....	......	1.20	4 50
California	37.2	78	12.0	1 08	11.1	1 00	33.1	60	18.9	77	17.9	1 00	86	80	....	......	1.35	12 20
Oregon	30.2	75	17.2	88	20.0	67	34.6	43	25.7	58	15.0	1 00	115	50	....	......	1.40	12 08
Nevada	34.8	1 00	14.5	1 20	......	......	31.7	90	21.4	1 20	......	......	90	1 35	....	......	1.30	15 00
Colorado	35.5	1 05	19.8	1 33	20.0	97	27.4	81	18.0	1 15	......	......	80	1 30	....	......	1.20	20 00
Territories	32.2	95	17.9	1 08	18.8	87	28.7	63	31.3	84	......	......	101	70	....	......	1.20	13 40

Table showing the average cash value per acre of farm products for the year 1881.

States.	Corn.	Wheat.	Rye.	Oats.	Barley.	Buckwheat.	Potatoes.	Tobacco.	Hay.
Maine	$30 94	$22 00	$16 05	$15 08	$18 70	$12 90	$40 04	....	$10 41
New Hampshire	29 75	23 71	11 13	18 04	18 20	15 00	50 40	$226 12	10 57
Vermont	30 70	26 46	17 14	16 80	22 10	14 47	52 50	284 30	12 33
Massachusetts	22 09	23 70	18 26	19 76	24 32	9 97	55 00	228 00	20 83
Rhode Island	24 30	15 60	12 88	19 68	22 41	9 72	60 00	....	20 41
Connecticut	20 40	25 13	14 60	15 85	19 80	12 35	66 30	251 52	17 64
New York	20 33	19 04	11 16	13 82	21 95	9 76	49 59	174 86	16 30
New Jersey	17 86	18 16	10 48	15 04	16 30	9 00	62 40	129 00	20 54
Pennsylvania	18 90	16 75	10 08	15 26	20 04	9 70	46 56	152 49	14 88
Delaware	8 64	14 14	7 05	8 82	....	13 48	48 00	....	18 05
Maryland	15 49	15 79	10 80	9 26	28 38	9 00	48 41	54 08	17 64
Virginia	10 65	10 64	5 89	4 19	17 05	7 08	34 40	47 52	17 56
North Carolina	9 24	10 28	6 01	5 02	11 50	6 82	26 60	59 80	13 17
South Carolina	6 63	9 40	7 20	10 67	16 80	....	21 31	34 72	19 36
Georgia	8 05	9 94	9 24	7 92	18 37	....	21 00	33 88	21 55
Florida	8 80	8 41	7 84	7 54	....	....	22 00	48 20	19 95
Alabama	9 60	10 48	8 15	8 10	13 15	....	48 20	39 78	19 78
Mississippi	10 56	8 96	8 68	8 75	....	....	36 80	48 79	18 94
Louisiana	12 74	4 95	12 18	12 28	....	....	36 10	....	17 82
Texas	11 78	17 78	16 80	16 35	17 37	....	39 20	54 72	13 75
Arkansas	13 91	7 80	7 37	9 80	....	....	48 56	40 66	18 00
Tennessee	8 93	8 30	5 60	7 95	14 63	6 97	34 40	41 80	16 22
West Virginia	16 80	18 13	9 41	7 90	18 45	8 34	44 55	42 75	13 62
Kentucky	11 90	9 82	10 99	7 66	15 13	7 03	37 00	61 60	15 60
Ohio	15 49	17 16	12 05	12 19	16 24	8 06	34 10	77 12	13 54
Michigan	17 64	13 62	11 37	15 04	22 60	13 05	46 40	62 25	15 12
Indiana	18 08	18 72	9 49	9 66	27 30	10 89	37 10	58 77	14 64
Illinois	11 25	10 00	14 10	14 36	13 83	7 52	50 40	54 20	14 82
Wisconsin	14 90	13 45	12 87	11 44	20 58	10 08	68 00	108 25	12 44
Minnesota	16 96	12 08	10 88	15 81	23 07	10 29	61 75	....	8 44
Iowa	11 35	7 00	9 12	8 91	15 39	11 16	56 10	....	8 28
Missouri	10 72	10 23	10 03	10 71	15 48	12 25	43 68	72 79	12 75
Kansas	10 56	9 55	9 08	7 92	9 22	9 40	49 40	....	5 83
Nebraska	10 69	6 80	7 88	7 92	4 89	7 86	47 04	....	5 40
California	21 22	12 36	11 10	13 86	14 55	17 90	68 00	....	16 47
Oregon	15 15	15 14	13 40	14 88	14 91	15 00	57 50	....	16 91
Nevada	24 80	17 40	....	28 58	25 68	....	121 50	....	19 50
Colorado	26 77	26 33	19 40	22 19	20 70	....	104 00	....	24 00
Territories	30 59	19 33	16 36	17 79	17 89	....	70 70	....	14 88

Table showing the average cash value per acre of the cereals, potatoes, tobacco, and hay of the farm, taken together, for the year 1881.

States.	Average value per acre.	States.	Average value per acre.
Maine	$13 06	Arkansas	$13 06
New Hampshire	13 66	Tennessee	9 33
Vermont	15 28	West Virginia	14 60
Massachusetts	23 13	Kentucky	13 67
Rhode Island	23 29	Ohio	15 76
Connecticut	22 41	Michigan	15 88
New York	17 79	Indiana	13 53
New Jersey	19 26	Illinois	12 23
Pennsylvania	17 00	Wisconsin	14 24
Delaware	11 71	Minnesota	12 72
Maryland	15 72	Iowa	10 03
Virginia	11 76	Missouri	11 18
North Carolina	9 84	Kansas	9 64
South Carolina	7 62	Nebraska	8 48
Georgia	8 37	California	15 26
Florida	8 72	Oregon	15 78
Alabama	9 68	Nevada	24 17
Mississippi	10 49	Colorado	26 89
Louisiana	13 03	Territories	19 58
Texas	12 76		

A general summary showing the estimated quantities, number of acres, and aggregate value of the principal crops of the farm in 1881.

Products.	Quantity produced.	Number of acres.	Value.
Indian corn.....bushels..	1,194,916,000	64,262,025	$759,482,170
Wheat.....do....	383,280,090	37,709,020	456,880,427
Rye.....do....	20,704,950	1,789,100	19,327,415
Oats.....do....	416,481,000	16,831,600	193,198,970
Barley.....do....	41,161,330	1,967,510	33,862,513
Buckwheat.....do....	9,486,200	828,815	8,205,705
Potatoes.....do....	109,145,494	2,041,670	99,291,341
Total.....	2,175,179,064	125,429,740	1,570,288,561
Tobacco.....pounds..	449,880,014	646,239	43,372,336
Hay.....tons..	35,135,064	30,888,700	415,131,366
Cotton.....bales..	5,400	16,710,730	259,016,315
Grand total.....	.....	173,675,409	2,287,768,558

Table showing the average yield and cash value per acre, and price per bushel, pound, or ton of farm products for the year 1881.

Products.	Average yield per acre.	Average price per bushel.	Average value per acre.	Products.	Average yield per acre.	Average price per bushel, pound or ton.	Average value per acre.
Indian corn ..bushels..	18.6—	$0 63.6—	$11 82	Buckwheat ...bushels..	11.4+	$0 86.5+	$9 90
Wheat .....do....	10.2—	1 19.3+	12 08	Potatoes.....do....	53.5—	90.9—	48 63
Rye .....do....	11.6—	93.3+	10 80	Tobacco.....pounds..	696.1+	9.6+	.....
Oats.....do....	24.7+	46.4—	11 48	Hay.....tons..	1.14	11 82	13 48+
Barley.....do....	20.9+	82.3—	17 21	Cotton.....pounds..	155	10	15 50

Table showing the estimated total number and total value of each kind of live stock, and the average price in January, 1882.

States.	Horses.			Mules.			Milch cows.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	88,726	$63 74	$5,655,395	301	$90 26	$27,185	151,506	$25 75	$3,903,674
New Hampshire	47,097	61 22	2,877,769	88	88 08	7,751	91,478	26 50	2,428,955
Vermont	75,957	62 10	4,717,551	286	87 56	25,025	227,374	25 63	5,667,174
Massachusetts	60,225	79 33	4,777,649	245	97 06	23,785	151,197	33 00	4,989,171
Rhode Island	9,758	80 11	781,712	46	96 75	4,404	21,245	30 50	647,973
Connecticut	45,839	62 40	2,860,354	544	93 46	50,816	117,432	32 30	3,794,660
New York	616,468	74 96	46,173,664	5,062	87 35	442,913	1,466,612	31 45	46,124,947
New Jersey	87,800	90 23	7,923,006	9,286	115 42	1,071,790	154,640	35 87	5,540,357
Pennsylvania	526,255	73 24	38,375,316	22,968	85 72	1,970,108	858,427	30 75	26,396,630
Delaware	21,980	70 55	1,552,639	3,939	87 62	345,125	27,330	25 40	694,411
Maryland	118,058	69 75	8,232,785	12,586	88 33	1,111,721	122,282	27 36	3,343,469
Virginia	221,026	60 24	13,314,606	33,934	72 39	2,456,482	250,631	18 60	4,716,366
North Carolina	134,384	65 30	8,775,316	82,281	73 64	6,059,173	229,812	14 08	3,224,282
South Carolina	60,857	72 40	4,369,047	67,675	84 20	5,698,235	139,182	16 50	2,296,508
Georgia	98,717	72 10	7,117,496	133,003	81 23	10,803,834	318,224	15 10	4,805,182
Florida	23,768	67 20	1,597,216	10,278	71 27	732,513	43,017	12 35	531,260
Alabama	115,069	68 50	7,882,596	122,292	70 85	8,664,388	274,157	13 25	3,632,580
Mississippi	113,432	73 20	8,303,222	131,676	80 35	10,531,856	269,519	14 63	3,943,068
Louisiana	104,950	61 36	6,439,465	77,441	78 73	6,096,930	144,989	17 85	2,588,054
Texas	828,349	35 50	29,761,176	139,216	52 30	7,280,683	600,650	18 16	10,907,806
Arkansas	150,723	58 60	8,832,368	91,436	75 44	6,897,932	244,419	17 20	4,204,007
Tennessee	266,651	52 60	14,025,843	172,966	72 65	12,566,125	300,794	17 83	5,363,157
West Virginia	124,888	52 16	6,506,352	6,164	58 67	361,642	157,427	24 95	3,9 7,804
Kentucky	368,921	55 75	20,567,346	113,830	67 15	7,643,684	295,845	26 00	7,691,970
Ohio	714,384	57 23	40,885,635	18,702	69 50	1,299,789	751,702	31 15	23,415,517
Michigan	388,354	65 40	25,397,566	5,194	78 38	407,140	388,434	30 30	11,730,405
Indiana	587,256	56 27	33,045,068	51,521	66 30	3,410,090	489,985	26 67	13,068,107
Illinois	1,012,861	58 60	59,353,609	122,045	69 70	8,506,536	874,572	29 40	25,712,417
Wisconsin	363,001	63 56	23,050,568	7,207	77 80	560,705	467,941	26 61	12,984,119
Minnesota	270,146	66 20	17,883,665	9,396	80 15	751,097	294,833	26 40	7,783,591
Iowa	816,092	59 15	48,271,843	45,372	72 34	3,277,870	906,438	27 56	24,971,980
Missouri	674,454	50 32	33,938,525	192,967	62 50	12,061,687	668,019	22 35	14,930,225
Kansas	461,070	51 27	23,638,237	68,761	65 46	4,496,969	447,616	26 62	11,915,536
Nebraska	221,258	60 25	13,374,744	21,390	70 50	1,508,029	186,305	27 20	5,041,928
California	246,067	47 30	11,636,115	26,910	69 20	2,008,372	214,280	33 70	7,066,958
Oregon	126,589	53 60	6,785,170	2,832	63 45	179,690	58,954	22 15	1,305,831
Nevada, Colorado, Territories	318,723	52 10	16,605,468	24,005	67 20	1,613,136	200,160	26 30	5,264,208
Total	10,521,554	*58 52	615,824,914	1,835,166	*71 35	130,945,378	12,611,632	*25 89	326,489,310

*General average.

Table showing the estimated total number and total value of each kind of live stock, and the average price in January, 1882—Continued.

States.	Oxen and other cattle.			Sheep.*			Hogs.*		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	181, 740	$25 35	$4, 607, 109	577, 236	$3 20	$1, 847, 155	73, 625	$11 37	$837, 116
New Hampshire	144, 678	26 00	3, 761, 628	213, 943	2 90	620, 435	53, 971	12 63	681, 654
Vermont	187, 983	24 90	4, 679, 532	444, 269	3 30	1, 466, 088	75, 620	11 15	843, 163
Massachusetts	109, 510	31 50	3, 449, 565	68, 659	3 00	205, 977	79, 322	15 30	1, 213, 627
Rhode Island	13, 700	29 30	401, 410	21, 514	3 10	66, 693	14, 262	12 70	181, 127
Connecticut	119, 361	31 15	3, 718, 095	60, 025	3 75	225, 094	61, 788	13 10	809, 423
New York	883, 829	29 20	25, 807, 807	1, 732, 332	3 43	5, 941, 899	736, 369	11 35	8, 363, 463
New Jersey	69, 654	32 40	2, 256, 790	118, 190	4 20	496, 398	214, 688	12 40	2, 662, 131
Pennsylvania	884, 842	28 70	25, 394, 965	1, 785, 481	3 30	5, 892, 087	1, 128, 570	11 28	12, 730, 270
Delaware	26, 005	21 37	555, 727	22, 077	3 12	68, 880	46, 740	9 67	451, 976
Maryland	138, 287	23 53	3, 253, 717	172, 896	3 18	549, 809	332, 054	7 20	2, 390, 789
Virginia	429, 829	17 74	7, 625, 166	502, 262	2 48	1, 245, 610	889, 499	4 70	4, 180, 645
North Carolina	429, 546	10 25	4, 402, 864	470, 871	1 30	612, 132	1, 380, 864	4 12	5, 689, 160
South Carolina	221, 590	11 47	2, 541, 637	120, 078	1 70	204, 133	590, 506	4 30	2, 539, 176
Georgia	597, 812	10 08	6, 025, 945	538, 141	1 45	780, 304	1, 426, 878	3 95	5, 636, 148
Florida	433, 700	8 35	3, 621, 395	58, 382	1 80	105, 088	284, 180	2 33	662, 139
Alabama	474, 950	9 15	4, 345, 792	354, 489	1 40	496, 285	1, 189, 839	4 05	4, 818, 848
Mississippi	446, 911	9 75	4, 357, 382	290, 571	1 45	421, 328	1, 163, 836	4 00	4, 653, 344
Louisiana	317, 664	11 95	3, 796, 085	135, 631	1 68	227, 860	627, 154	4 03	2, 527, 431
Texas	3, 443, 784	12 20	42, 014, 165	6, 850, 000	2 10	14, 385, 000	1, 896, 300	3 35	6, 352, 605
Arkansas	445, 071	11 67	5, 193, 979	249, 225	1 42	353, 899	1, 471, 192	3 00	4, 413, 576
Tennessee	470, 206	13 72	6, 451, 226	675, 478	1 70	1, 148, 313	2, 050, 261	4 55	9, 328, 688
West Virginia	298, 473	22 37	6, 676, 841	681, 517	2 48	1, 690, 162	459, 552	4 70	2, 159, 894
Kentucky	509, 397	23 15	11, 792, 541	990, 266	2 85	2, 822, 258	1, 935, 946	4 65	9, 002, 149
Ohio	1, 038, 486	27 50	28, 558, 365	4, 951, 511	3 10	15, 349, 684	2, 827, 200	7 32	20, 695, 104
Michigan	501, 963	27 20	13, 653, 910	2, 320, 752	3 12	7, 240, 746	915, 867	7 57	6, 933, 113
Indiana	851, 440	23 30	19, 838, 552	1, 111, 516	2 65	2, 945, 517	2, 867, 772	6 80	19, 500, 850
Illinois	1, 442, 489	26 51	38, 240, 383	1, 026, 702	2 85	2, 926, 101	4, 186, 213	7 10	29, 867, 112
Wisconsin	637, 752	23 37	14, 904, 264	1, 350, 175	2 50	3, 375, 437	1, 117, 587	7 50	8, 381, 527
Minnesota	391, 175	21 67	8, 476, 762	278, 302	2 45	681, 840	389, 043	6 75	2, 626, 040
Iowa	1, 775, 427	22 90	40, 657, 278	482, 631	2 82	1, 361, 160	5, 551, 571	7 05	39, 138, 576
Missouri	1, 362, 746	20 36	27, 745, 509	1, 425, 411	2 00	2, 850, 822	4, 097, 811	4 37	17, 907, 434
Kansas	1, 094, 687	22 16	24, 258, 264	649, 572	2 50	1, 623, 930	1, 787, 969	6 15	10, 996, 009
Nebraska	692, 941	23 00	15, 937, 643	249, 316	2 60	648, 222	1, 316, 227	6 90	9, 081, 966
California	422, 433	21 77	9, 196, 966	6, 352, 344	1 65	10, 481, 368	585, 443	6 20	3, 629, 747
Oregon	331, 724	15 12	5, 015, 667	2, 333, 162	1 60	3, 733, 059	160, 909	5 85	941, 318
Nevada, Colorado, Territories	1, 458, 534	20 47	29, 856, 191	5, 351, 247	2 15	8, 925, 181	185, 627	6 55	1, 215, 857
Total	23, 280, 238	†19 89	463, 069, 499	45, 016, 224	†2 37	106, 595, 954	44, 122, 200	†5 98	263, 543, 195

* These estimates include all pigs, on the basis of Census returns of 1880.

† General average.

CATTLE EXPORTS.

Prior to 1877 the exports of stock were small and comparatively uniform. In October of that year commenced the export of beeves of the short-horn and other grades from northern seaports. The cattle hitherto shipped were sent from Texas and Florida, and went mostly to the West Indies. These cattle averaged $16 to $17 per head, and the value of the aggregated cattle exported never went much above $20 until the era of fat beeves commenced. The table of average prices discloses the fact that the shipments for three months of western cattle brought the average for 1877 up to $31.86; the next year the average was $48.69, and as the proportion of short-horn blood increased, the average advanced, and stood at $77.03 in 1881. While the long horns of Texas averaged $16.84 in that year, northern beeves exported from Boston averaged $99.68, or one short-horn equal to six Texans. The tables, which are deductions from the customs records, will be found suggestive.

The increase in exportation of horses was rapid from 1870 to 1878, but a steady decline has followed since that date. The decline in the movement of mules commenced two years later. The prospect is favorable for continuance of the foreign trade in both horses and mules. The export of sheep on foot has been declining for four years. Pork products are shipped to foreign countries in preference to live hogs.

Statement of exportations of farm animals from 1871 *to* 1881, *inclusive.*

Years.	Horses.	Mules.	Horned cattle.	Sheep.	Hogs.
1871	1,186	1,930	20,530	45,465	8,770
1872	1,722	2,121	28,033	35,218	86,110
1873	2,814	1,659	35,455	66,717	99,720
1874	1,482	1,252	56,067	124,248	158,581
1875	3,220	2,802	57,211	124,416	64,979
1876	2,030	1,784	51,593	110,312	68,044
1877	2,042	3,441	50,001	179,017	65,107
1878	4,104	3,860	80,040	183,995	29,284
1879	3,915	4,153	136,720	215,680	75,129
1880	3,060	5,198	182,756	209,137	83,434
1881	2,523	3,207	185,707	179,919	77,456
1882	2,248	2,632	108,110	139,676	36,368

Exports of cattle from 1871 to 1881, *inclusive, by customs districts.*

Years.	New York.		Boston.		Key West.		Saluria.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
1871	1,070	$128,785	4	$250	7,171	$98,102	219	$1,896
1872	1,037	106,638	1	200	17,712	291,601	84	382
1873	990	98,675	6	600	17,088	278,244	276	3,080
1874	1,267	226,894	1	112	17,627	317,574	159	1,953
1875	1,564	284,938	8	840	11,453	178,682	10,546	159,139
1876	1,589	160,268	144	18,720	8,482	112,874	19,000	324,825
1877	4,868	465,183	1,566	175,575	9,071	120,244	17,830	306,500
1878	13,887	1,233,223	13,887	1,346,748	16,190	220,764	20,871	371,700
1879	27,210	2,340,997	35,593	3,515,069	25,466	346,300	21,441	368,878
1880	65,161	6,047,914	52,842	5,110,563	28,600	400,815	16,526	290,929
1881	56,921	5,330,502	70,072	6,984,838	22,580	318,189	15,705	264,476

Exports of cattle from 1871 *to* 1881, *inclusive, by customs districts*—Continued.

Years.	New York.	Boston.	Key West.	Saluria.	United States.		
	Average value per head.	Average value per head.	Average value per head.	Average value per head.	Number.	Value.	Average value per head.
1871	$120 98	[illegible] 50	$12 68	[illegible]	20,530	$462,491	[illegible]
1872	102 83	200 00	16 47	11 24	28,033	565,719	20 1[illegible]
1873	99 67	100 00	16 20	10 96	35,455	695,957	19 [illegible]
1874	179 08	112 00	18 02	12 28	56,067	1,150,257	20 53
1875	150 22	113 33	15 60	15 09	57,211	1,103,085	19 2[illegible]
1876	100 86	130 00	18 31	17 10	51,593	1,110,703	21 5[illegible]
1877	99 77	112 12	18 26	17 19	50,001	1,593,080	31 [illegible]
1878	92 13	96 98	13 64	17 81	80,040	3,896,818	48 [illegible]
1879	86 08	96 76	13 90	17 20	136,720	8,379,200	61 [illegible]
1880	92 81	96 71	14 90	17 60	182,756	13,344,195	73 [illegible]
1881	93 65	90 66	14 [illegible]	16 84	185,707	14,304,103	77 [illegible]

ADVANCE IN PRICE OF BEEVES.

The course of prices of beeves for six years past is suggestive. The Chicago market, the center of the trade for domestic consumption and export, can furnish a sufficient history of prices. For three years, from 1876 to 1879, there was a constant decline, amounting to 20 per cent. for choice beeves during this period. Then commenced a rise, which in three years exceeded 40 per cent., the advance moving slowly in 1879 and 1880, but much more rapidly during 1881, the increase being fully $1 per hundred of live weight during the year. But after December, 1881, the advance was extraordinary, if not unprecedented, the range for "choice" being from $5.85 to $6.35 in January of 1882, and from $8.65 to $8.90 in June, or more than 45 per cent. advance in six months.

The advance in the value of extra beeves in these six months was almost 40 per cent., and nearly as much in June as in five months preceding. The record of prices on the 1st of January is as follows:

Years.	Extra.	Choice.	Good.	Medium.
1876	....	$5 25 to $5 75	$4 50 to $5 10	$4 00 to $4 50
1877	....	5 00 to 5 50	4 50 to 4 80	3 80 to 4 40
1878	$5 15 to $5 40	4 50 to 4 90	4 00 to 4 40	3 50 to 3 85
1879	4 60 to 5 00	4 10 to 4 35	3 60 to 4 00	3 00 to 3 50
1880	5 00 to 5 25	4 60 to 4 75	....	*3 50 to 4 40
1881	5 75 to 6 25	4 85 to 5 40	....	*3 75 to 4 65
1882	6 50 to 6 85	5 85 to 6 35	4 50 to 5 15	....

*Good to medium includes two grades.

The upward movement of 1881 is only a prelude to the advance since January, as follows:

Months.	Extra.	Choice.	Good.	Medium.
January	$6 50 to $6 85	$5 85 to $6 35	$5 50 to $5 75	$4 50 to $5 15
February	6 30 to 6 50	5 85 to 6 10	5 25 to 5 50	4 50 to 5 00
March	6 60 to 6 75	5 90 to 6 35	5 50 to 5 75	5 25 to 5 40
April	7 17 to 7 65	6 75 to 7 00	6 25 to 6 60	5 75 to 6 00
May	7 60 to 7 85	7 30 to 7 50	6 90 to 7 15	6 50 to 6 75
June	9 15 to 9 40	8 65 to 8 90	8 00 to 8 50	7 00 to 7 50

In "butcher's stock" the range was from $2.75 to $4.25 in January, and from $3.50 to $6 in June; the latter rate being a reduction from May prices.

The cause of this great advance, which occasioned some surprise among producers and great consternation among consumers, has been often asked. There are several causes. The exportation of extra beeves, which commenced in 1877, and increased year by year, both as live and dead meat, is an element, but does not account for the spasmodic jumps in the rates of recent months. Another element of equal or superior strength is the great destruction of cattle on the plains, and in the parks and valleys of the Rocky Mountains, in the winter of 1880–1881, by cold and starvation, amid the drifts and severities of the unusual season. While this cause tended to stiffen prices in 1881, it is not continuously operative, as the past winter was very favorable, and numbers are now increasing rather than diminishing. The third cause, acting in conjunction with the two preceding with a cumulative effect, is the "failure" of the last corn crop, the high price of feeding material—all together producing an excitement in the market that partook of the nature of panic.

There are assumed causes, assigned by uninformed writers, which are baseless or without appreciable weight, such as the drowning of cattle in the Mississippi overflow. It is true there was some local loss in numbers, but not in prospective beef supply of the great markets, or appreciably in home supply, as beef is scarcely a product of cotton plantations.

What of the future of prices? There has already been a decline since the commencement of improvement of the corn prospects of 1882. While prices cannot continue to increase, and cannot be permanently maintained under full harvests, it is probable that the low rates of a few years ago will not soon prevail, if ever. The general tendency throughout the world is toward a high rate for meat, compared with grain and other animal products.

FARM ANIMALS AT CHICAGO.

The increase in the cattle movement to Chicago has been steady, and is attaining large proportions, amounting to nearly two hundred per cent. in ten years. The receipts of swine have more than doubled in the same time. Sheep are moving in larger numbers, but three times as many cattle and twelve times as many hogs are now annually received in this market.

Total receipts of stock for sixteen years.

Years.	Cattle.	Calves.	Hogs.	Sheep.	Horses.
1865 (five days)	618	....	17,764	1,488	....
1866	393,007	....	961,746	207,987	1,553
1867	329,188	....	1,696,738	180,888	817
1868	324,524	....	1,706,782	270,891	1,932
1869	403,102	....	1,661,869	340,072	1,524
1870	532,964	....	1,693,158	349,853	2,537
1871	543,050	....	2,380,083	315,053	6,963
1872	684,075	....	3,252,623	310,211	12,145
1873	761,428	....	4,437,750	219,784	20,289
1874	843,966	....	4,258,379	333,655	17,588
1875	920,843	....	3,912,110	418,948	11,346
1876	1,096,745	....	4,190,006	364,095	8,159
1877	1,033,151	....	4,025,970	310,240	7,874
1878	1,083,068	....	6,339,654	310,420	9,415
1879	1,215,732	....	6,448,330	325,119	10,473
1880	1,382,477	....	7,059,355	335,810	10,398
1881	1,498,550	48,948	6,474,844	493,624	12,900
Total	13,046,468	48,948	60,517,161	5,180,083	125,922

Total shipments of stock for sixteen years.

Years.	Cattle.	Calves.	Hogs.	Sheep.	Horses.
1866	263,693	....	482,875	75,447	162
1867	203,580	....	758,780	50,275	387
1868	215,987	....	1,020,329	81,634	2,185
1869	294,717	....	1,086,305	106,690	1,538
1870	391,709	....	924,453	116,711	2,488
1871	401,927	....	1,162,286	135,084	5,482
1872	510,025	....	1,835,594	145,016	10,625
1873	574,181	....	2,197,557	115,225	18,560
1874	622,929	....	2,330,361	180,555	16,[illegible]
1875	696,534	....	1,582,643	242,604	11,129
1876	797,724	....	1,131,635	195,925	6,[illegible]
1877	703,402	....	951,221	155,354	6,[illegible]
1878	699,108	....	1,266,906	156,727	8,178
1879	726,903	....	1,692,361	159,265	8,269
1880	886,614	....	1,394,990	156,510	8,712
1881	938,712	33,465	1,289,679	258,[illegible]	11,166
Total	8,927,745	33,465	21,107,984	2,329,971	120,867

The *difference between receipts and shipments* represents the numbers taken in Chicago for home consumption, a large proportion of which is used in meat "manufacture," in cutting and packing for shipment, and sale as "dead meat." The horses, which do not contribute to the meat trade of Chicago, are reported in small numbers:

	Cattle.	Calves.	Hogs.	Sheep.	Horses.
Receipts	13,046,483	48,948	60,517,161	5,160,033	135,922
Shipments	8,927,745	33,465	21,107,984	2,329,971	120,867
Home supply	4,118,738	15,483	39,409,177	2,830,062	15,055

Live stock receipts at Union Stock Yards for the year ending December 31, 1881.

	Cattle.	Calves.	Hogs.	Sheep.	Horses.	Totals.
Baltimore and Ohio Railroad	2,115	9,000	29,200	8,364	89	48,628
Chicago and Alton Railroad	161,076	269	464,965	47,290	2,341	675,941
Chicago, Burlington and Quincy Railroad	489,708	1,028	2,042,791	121,674	2,948	2,658,139
Chicago and Eastern Illinois Rail-Road	29,511	804	134,411	17,312	271	182,309
Chicago and Grand Trunk Railroad	3,567	4,011	12,972	2,625	989	24,164
Chicago, Milwaukee and Saint Paul Railroad	88,395	4,839	479,736	65,877	552	638,399
Chicago and Northwestern Railroad	238,429	4,885	1,042,963	92,812	633	1,380,042
Chicago, Rock Island and Pacific Railroad	236,752	248	960,668	37,188	1,075	1,255,928
Illinois Central Railroad	91,435	1,270	689,620	40,807	1,022	824,154
Lake Shore and Michigan Southern Railroad	8,929	13,990	75,366	18,195	1,145	117,625
Michigan Central Railroad	3,586	5,666	42,849	8,259	681	61,041
Pittsburgh, Cincinnati and Saint Louis Railroad	5,312	1,230	51,092	4,315	256	62,205
Pittsburgh, Fort Wayne and Chicago Railroad	3,795	1,736	36,438	1,877	154	44,000
Wabash, Saint Louis and Pacific Railroad	180,896	263	339,714	25,817	510	547,200
Driven into yards	5,049	154	2,039	1,217	3	8,462
Totals	1,498,550	48,948	6,474,844	493,624	12,969	8,528,875

The Chicago, Burlington and Quincy line drains the central belt of beef production, and the Chicago and Northwestern, the Rock Island, Chicago and Alton, and Wabash roads hold each a share of the traffic, while many other roads aid in collecting the herds that are shipped or slaughtered at Chicago. The same lines are prominent in the movement of other kinds of stock.

WINTER FEEDING OF FARM ANIMALS.

It has long been a question with thoughtful observers of average results of winter feeding of cattle, whether the manurial remainder of hay, straw, and corn stover fed during the winter may not be the only profitable result of the winter's feeding. This material represents some hundreds of millions of dollars in value, and it is saved with much labor and expense, and "fed out" daily for some five months of the year in middle latitudes. Comparatively little of it does more than keep up animal-heat, acting as fuel in the animal furnace, but not as a flesh former.

To ascertain the results of prevailing practice, and learn whether this loss is a necessity or a blunder little short of criminal waste, the inquiry was instituted as to the average increase in weight of stock two years old and upwards, during the season of winter feeding. Of course a precise average is impracticable, as the facts vary so widely according to prevailing practice, not only in different counties, but on different farms; and the judgment of different observers would also be variant if reporting upon the same district. But the returns show clearly and conclusively that—

1. A considerable percentage of stock fed actually lose in flesh and in weight.
2. Another large fraction maintain their weight and add to bone and size of frame, but decrease in flesh.
3. A small proportion make increase of weight, 5, 10, 20, or 30 per cent., depending upon comfortable shelter and amount and variety of feed.

The difference between a loss of 5 or 6 per cent. and a gain of equal proportion, say 100 pounds in the northern belt, in which winter feeding is a general necessity, is equivalent, at the low average rate of $3 per hundred, to more than fifty million dollars. This amount could easily be made if only a part of the difference between average neglect and skillful feeding were obviated.

The New England returns claim a small gain in most counties; a few report growth in frame with loss in flesh, and occasionally an unqualified reduction in weight. In Vermont the gain is more general and somewhat greater, usually 5 to 10 per cent., while some assume an increase of 25 per cent. In Western Massachusetts a good gain is reported; in the Connecticut Valley 15 per cent.

The estimate of 5 to 10 per cent. gain is very general in New York. A few report 20; average, about 10. Some make any increase to depend on feeding with grain. In Broome County the difference between material loss and decided gain is made dependent on a ration of corn meal. The reported gain in New Jersey is about the same as in New York.

Three-fourths of the returns from Pennsylvania claim a gain of flesh in winter. In Lancaster, Delaware, Bedford, Clinton, and other good farming districts, where cattle are fed for beef, a gain of 30 to 40 per cent. is claimed; in most of the counties, according to the care or neglect which characterizes their cattle husbandry, the percentage falls to 30, 15, 10, or less. In several a loss of 3 to 5 per cent. is assumed, and probably with good judgment. The average gain is not more than 10 per cent.

Delaware and Maryland claim a small gain, averaging 5 to 10 per cent. The gain is very little in Virginia. In Smyth County, a fine grazing region, gain is estimated at 150 to 200 pounds. Matthews and Warwick estimate 20 per cent. Loudoun is placed at 15. The usual estimate is 5 to 10, and several reports indicate a loss. Among counties that report a loss are Patrick, Clarke, Hanover, Louisa, and King George. Others say that cattle about "hold their own" in winter. A fair average of the somewhat indefinite returns scarcely exceeds 5 per cent.

The gain and loss in North Carolina about balance each other. The cattle have lived through the winter. It is not much better in Georgia. Some report a loss of flesh and weight, others maintain a *statu quo*, while a few assert a small gain. In Texas cattle "sometimes lose and sometimes gain," or "merely live," and in some cases they are not fortunate enough to live. It is rather a loss than a gain in Arkansas. Opinions of Tennessee reporters are about equally divided between loss and gain. In Anderson County it is estimated that two-year-olds will lose 30 per cent. in winter. "If well fed," they will gain 20 per cent., say several reporters; "but they are not well fed as a rule, and so the actual result is a loss of 20 per cent."

There is a great difference in fact and in opinion in the West Virginia returns. The difference lies between a current habit of neglect and a thrifty custom of systematic feeding for flesh. "When sheltered and fed corn, steers two years old will gain 100 to 200 pounds" in Pleasants; while in McDowell, Nicholas, and other southern counties a loss is usually suffered. Taking the State altogether, it is evident that the average increase of winter months is small.

The verdict of Ohio is that cattle well protected and properly fed gain in flesh and in weight in winter. If unsheltered and kept on coarse hay and straw, they will lose. As a fact, the stock of many counties is in worse condition in spring than in fall, and in some it is probable that the loss in weight is not compensated for by growth in bone and frame. There are others where the custom of feeding as a business has compelled economy in flesh production, which by no means is equivalent to stinting in feeding material. The statements of correspondents are in some cases estimated averages, in others hypothetical estimates of what might and should be. The Fayette return estimates with proper care and feeding a gain of 150 to 200 pounds during the winter. In Clinton the gain is placed at 50 to 150 pounds in the hands of those esteemed good feeders. Under such favorable circumstances, the gain is placed at 20 per cent. in Lorain, 15 to 30 in Seneca, 20 in Van Wert and Lawrence, 15 to 20 in Fairfield, if grain is fed; 10 per cent. in Highland, Union, and Wyandot; 15 to 20 in a mild winter in Vinton; 10 per cent. in Champaign, Noble, Pike, and Sandusky; 5 to 10 per cent. in Auglaize, 5 in Fulton.

It is not stated that these are the average gains of these counties, the favorable conditions required not existing on all farms. It is stated that in Geauga, however, cattle "gained in weight this winter 20 to 30 per cent." It is claimed that in Coshocton the actual gain of the winter months is not more than a fourth as much as in the autumn. It is held in Cuyahoga that on some farms there is gain, on others loss, dependent on feed and care. Cattle are assumed barely to "hold their own" in Greene, Hocking, and Lucas. A loss from 10 to 20 per cent. is the estimated average result in Adams, Athens, Jefferson, Richland, and Wayne. The returns from many other counties give similar statements, showing that good farmers secure a gain, and others suffer loss of flesh. It is repeatedly stated that ordinary usage scarcely maintains the status of the autumn.

In Michigan, fully half of the counties report some gain, and half of the remainder a loss varying from 5 to 30 per cent. All show a wide discrepancy between the actual and the possible. A few of the remarks are appended.

MICHIGAN.—*Clinton*: If well fed and cared for will gain, say, 20 per cent.; the average hold their own as ordinarily cared for. *Barry*: Always gain; if well fed should gain from one to two pounds per day. *Crawford*: As a rule, if not properly cared for, lose 10 per cent.; farmers are learning to take better care of their young cattle. *Allegan*: If cared for will gain three pounds per day in flesh; 30 per cent. of the young cattle lose during the winter months. *Grand Travers*: Are usually fed ruta-bagas and potatoes, and gain handsomely. *Chippewa*: Always gain, when well fed, say 10 per cent. *Leelenaw*: Generally lose 15 per cent.; if fed grain and roots will gain about 20 per cent. *Saginaw*: If extra fed will gain; generally lose about 10 per cent. *Benzie*: Are doing well if they hold their own. *Ionia*: About an even thing; those who take good care of their stock are rewarded by an increase of weight; others (and I think they are in the majority) do not take care of their stock. I am pleased to say that year by year better methods of caring for stock is finding favor and being adopted by our farmers.

Indiana farmers report a gain in cases of good and judicious feeding, yet the majority state as an existing fact that cattle lose in weight, in many cases in excess of any development in bone and frame. A few of the more suggestive statements are quoted:

INDIANA.—*Benton*: Yearlings will not gain; two-year-olds will gain, by extra care, 200 pounds each. *Clarke*: If sheltered will gain 10 per cent.; if not sheltered will lose 10 per cent. *Dearborn*: Generally lose in weight on rough feed; if fed grain will gain 5 per cent. *Fulton*: If properly fed and cared for would gain; if not, would lose, say, about 20 per cent. in either case. *Floyd*: All young cattle have gained wonderfully this winter, considering the fact that our farmers had little to feed them except fodder, hay, and the grass of the pasture. *Fayette*: If fed some grain and good clover hay will gain one and a half pounds per day; if fed nothing but straw and husks will lose one-half pound a day. *Clay*: Grow some in stature, but shrink in weight from 15 to 25 per cent. *Decatur*: When stabled and fed on grain will gain, perhaps, 100 pounds from December to April; if not sheltered and properly cared for will lose from 50 to 100 pounds. *Franklin*: If properly cared for will gain in growth what they lose in flesh, often more. *Hancock*: Depends upon the care they receive; as a rule they lose 10 per cent. *Huntington*: If properly cared for, fed, and stabled will gain 25 per cent.; if not, will lose 25 per cent. *Clinton*: Require extra care to make them hold their own; usually lose from 12 to 15 per cent. *Lagrange*: With warm stabling and heavy feeding can be made to gain; usually lose. *Wells*: Feeders say that if their steers weigh as much in the spring as in the fall they have done well.

It is evident from these returns that in Illinois, the center of cattle feeding in the United States, with the exception of the herds of professional feeders, cattle make little actual gain in weight during four months of winter, and that in many instances there is a serious loss of condition which further impairs the capacity for gain under the best conditions of summer pasturage. Note the following extracts:

Fulton: Lose if not fed on grain and well sheltered, say, 5 per cent. *Lee*: Usually gain 25 per cent. *Mason*: Gain in value, through age rather than condition, say, 15 to 20 per cent. *Schuyler*: This depends much on the feeding. I think they are lighter on the first day of May than they were on the first of January. *Whiteside*: Lose 15 per cent.; when well housed and fed gain 25 per cent. *Henderson*: If well fed with plenty of grain and hay, will gain about 55 per cent. *Jo Daviess*: When properly fed will gain 10 per cent. *Rock Island*: In the hands of good feeders they gain. *Stark*: Generally lose flesh, because they are not fed much grain, say, one-fifth. *Williamson*: Generally a slight gain, about 15 per cent. *Hancock*: When sheltered and well fed they gain; all is due to the amount of care bestowed. *Will*: Lose, should think, 10 per cent. *Kankakee*: The growth will be from 5 to 10 per cent.; about hold their own in flesh. *Franklin*: Generally lose 20 per cent. This winter they have gained 25 per cent., caused by being pastured on green wheat fields. *Bond*: With ordinary feed will gain 10 per cent. This winter they have lost 20 per cent. *De Kalb*: If fed corn might gain 10 per cent.; if not, the loss will be 3 to 5 per cent. *Clark:* In the hands of regular feeders they gain from 10 to 25 per cent.; but in the hands of the average farmer they lose from 5 to 20 per cent. *Cook:* No bullocks raised for feeding; expect our heifers to gain in flesh all winter. *Clinton:* Have lost this winter at least 25 per cent. *Edgar:* Generally lose about 20 per cent. This year, owing to the scarcity of feed, have lost 33 per cent. A good many have died from poverty. *Fayette:* Have lost because of so little feed. *Henry:* Generally lose about 5 per cent. *Hamilton:* Lose 20 per cent. *Jasper:* Usually lose 20 per cent. *Kendall:* Generally lose about 10 per cent.; some exceptions. *McHenry:* Generally gain in flesh, say, about 10 per cent. *Richland:* As a rule, they lose about 30 per cent. *White:* Some improve; others lose; depends on the feeding and care. *Cumberland:* Lose about 10 per cent. *Greene:* Unless well fed on corn will lose. *Iroquois:* The past winter have gained; estimated 10 per cent. *Jefferson:* Gained but little, for the reason that they are not sheltered from the storm. *Morgan:* When placed on full feed gain; but when fed on stalks and straw they lose about 25 per cent. *Pope:* None fed. *Shelby:* Have lost about 12 per cent. the past winter. *Tazewell:* If fed corn with hay and stalks will gain 100 pounds during the winter; if fed only hay, will lose. *Warren:* Generally lose from 5 to 8 per cent. *Clay:* If sheltered and well fed will gain. *La Salle:* Gain in growth and flesh 10 per cent. *Johnson:* The way they are fed and cared for as a rule lose 10 per cent. *Kane:* When well housed will gain 10 per cent. *Saline:* Gain, when properly cared for, 20 to 25 per cent. *Woodford:* Gain 10 per cent. *Winnebago:* Generally no gain. *Gallatin:* When fed, gain. *Montgomery:* Lose about 20 per cent. *Brown:* Depends upon the manner they are fed and handled; in a majority of cases gain from 10 to 25 per cent. *Carroll:* Generally gain. *Effingham:* When well fed and sheltered, gain 5 per cent. *McDonough:* Always gain when well fed and sheltered 30 to 40 per cent. *Sangamon:* When poorly fed will lose from 100 to 300 pounds; well fed will gain from 200 to 300 pounds. *Ogle:* Those properly fed and sheltered gain 15 per cent. *Vermillion:* When fed on corn gain; if only on rough food will lose. *Piatt:* If properly fed and sheltered will gain; on an average hardly hold their own. *Stephenson:* Two-year-olds by feeding grain will gain a small per cent.; yearlings will lose. *Boone:* About hold their own. *Coles:* Cannot improve in winter from the fact that they are so much exposed to the inclement weather. *Jackson:* Generally lose from 5 to 10 per cent. *Washington:* If properly fed and sheltered will gain, I would say, from 15 to 30 per cent. *Du Page:* Should gain, if properly cared for, 15 per cent.

Wisconsin returns generally indicate a slight gain in winter. Some reports assume a loss, and others maintain the *statu quo*. In Minnesota a pretty even balance between loss and gain is mentioned in the returns. Iowa claims a small gain in two-thirds of the counties, but no large percentage, except for that portion of the stock which has extra attention and feed. In Missouri the estimates of loss fully balance those of gain, and leave a distinct impression that the net result of the winter's feed and care has been a bridging over of an unthrifty period, and a safe approach to a season of growth and profit, in which stock can take their supplies directly from the hand of nature. In Kansas, a gain in size with a loss of flesh is noted, as a rule. With high feeding large gains are sometimes made. Several counties report an actual loss in weight. A few extracts are appended.

Elk: No yearlings fed for market; two-year-olds on full feed 150 days will make an average gain of 225 pounds, or 25 per cent. *Coffey:* If well fed and sheltered will gain from ten to 15 per cent.; stock shippers say from 8 to 12 per cent.; as fed by most farmers they usually lose from 3 to 10 per cent. *Rooks:* Gain in size, but lose in flesh, about retain their own. *Woodson:* Lose from 10 to 15 per cent. in the hands of farmers who raise cattle and grain to sell; but with cattle men they gain from 4 to 5 per cent.; not many two-year-olds are sold to butchers or put on the market. *Reno:* When fed grain will gain about 10 per cent., but when not they will barely hold their own. *Lincoln:* Gain in the fore part of the winter and lose in the latter part; average loss 3 per cent. *Cloud:* Will gain from 200 to 500 pounds; the manner of feeding makes the difference. *Crawford:* If properly fed and housed will make a gain of 5 to 20 per cent. *McPherson:* Generally lose, say, about 20 per cent. of fall weight. *Labette:* Unless especially fed to fatten, lose on an average 15 per cent. *Sumner:* Gain; Texas cattle on full feed have gained 25 per cent.; domestic or graded stock gain 33 per cent. *Ottawa:* About hold their own; when three years old, if corn fed, will gain rapidly. *Kingman:* When fed on hay, will about hold their own; when fed grain, will gain.

In Nebraska gain is confined exclusively to the better class of farmers, who feed and shelter well. Common usage is usually attended with loss of condition as to flesh, and sometimes actual loss of weight. Increase is conditional, with great uniformity, in these reports, upon somewhat exceptional treatment.

The California returns indicate a loss in winter under the treatment usually practiced. At the same time the claim of possible gain is distinctly made, and in Fresno County it is asserted that, with good feeding, the gain is greater in winter than in summer.

The lesson of this branch of the investigation is: That a large portion of the farmers of the United States do not realize, practically, at least, the physiological necessity for continuous growth in the production of meat of juicy, rich, even quality, or the economic necessity of making every pound of feed yield the highest possible fraction of a pound of flesh. To practice this ideal fully is not easy, even to the highest skill and ripest experience; but an approach to it, in popular practice, would save many millions annually.

GROWTH OF THE COTTON INDUSTRY.

For seven decades after the invention of the saw-gin, the increase of cotton-growing was comparatively steady, though somewhat slow, until the era of improvement in cotton machinery. In 1844 the product was close to two and a half million bales, an aggregate attained but once in the next six years. The crop was subject then, as now, to annual fluctuations in product and acreage, causing changes in price, which in turn stimulated or depressed the ambition for extension of area. As the factory system extended, the demand grew stronger and more imperative. In 1851 the product exceeded three million bales, and advanced to almost five million in 1860. After 1861 the cultivation was nearly suspended during four years of war, causing a cotton famine of great severity, which British spinners attempted to mitigate by encouraging cotton-growing in India, with a very moderate degree of temporary success.

There was naturally great despondency, with land in weeds and labor beyond control, with little money to pay for voluntary labor, and less of skill and experience for its profitable handling. Dark prophecies were uttered; the seeming prosperity of old would never return, and *ante-bellum* crops could never be gathered. This was the popular view; but cooler brains and wiser judgments forecasted heavier crops and a truer and better prosperity than ever.

Seventeen crops have been gathered since the advent of peace, and the eighteenth is growing. A sufficient period has elapsed for a comparison of progress. The results are easily epitomized. The annual "commercial movement," which is not identically the year's crop, but sufficiently near it for practical purposes, the exportation, and the remnant left for American consumption, during a period of seventeen years before the war, are thus compared with similar data for the seventeen crops that have been gathered since:

	Crop movement.	Exportation.	Consumption.
	Bales.	*Bales.*	*Bales.*
First period	51, 330, 790	39, 913, 005	11, 422, 779
Second period	68, 377, 376	46, 892, 528	21, 494, 210

A million bales per annum above the average of the first period, though beginning with a smaller production than that of 1844, may be deemed a good showing for the new régime; an average of 4,000,000 bales for the recent period, and of 3,000,000 for the former era.

The exportation is greater by 7,000,000 in the seventeen years just passed, while the remainder left for consumption is greater by almost 10,000,000, nearly double the consumption prior to the war, attesting the rapid growth of the American factory system, which is of late happily extending through the cotton States at a gratifying rate. This consumption is nearly four times as great in 1882 as it was in 1845, while the annual exportation is increased but 75 per cent. The time will doubtless come—and the day should be hastened by the rapid extension of coarse manufactures in the South, and the fine textures in the North—when half to two-thirds of our production shall be manufactured in this country.

The accompanying diagram presents to the eye very clearly the facts which are here co-ordinated.

In the following table the year of the crop movement commences September 1, and closes August 31 of the succeeding year. The exportation closes June 31. It is the commercial record, as published in the Financial Chronicle.

Years.	Movement.	Exportation.	Consumption.
	Bales.	*Bales.*	*Bales.*
1844–'45	2,484,662	2,083,756	454,[illegible]
1845–'46	2,170,537	1,666,792	488,[illegible]
1846–'47	1,860,479	1,241,222	506,735
1847–'48	2,424,113	1,858,261	606,[illegible]
1848–'49	2,808,596	2,227,844	506,[illegible]
1849–'50	2,171,706	1,590,155	562,[illegible]
1850–'51	2,415,257	1,988,710	466,[illegible]
1851–'52	3,090,029	2,443,646	678,[illegible]
1852–'53	3,352,882	2,528,400	761,[illegible]
1853–'54	3,035,027	2,319,148	715,571
1854–'55	2,932,339	2,244,209	678,[illegible]
1855–'56	3,645,345	2,954,606	776,[illegible]
1856–'57	3,056,519	2,252,657	819,[illegible]
1857–'58	3,238,962	2,590,455	[illegible]
1858–'59	3,994,481	3,021,403	916,150
1859–'60	4,823,770	3,774,173	954,[illegible]
1860–'61	3,826,086	3,127,[illegible]	[illegible]
Total	51,330,790	39,912,005	11,422,77
1865–'66	2,228,987	1,552,457	617,[illegible]
1866–'67	2,059,271	1,562,761	664,[illegible]
1867–'68	2,498,895	1,657,015	896,615
1868–'69	2,439,039	1,448,020	906,[illegible]
1869–'70	3,154,946	2,178,917	906,[illegible]
1870–'71	4,352,317	3,166,742	1,160,[illegible]
1871–'72	2,974,351	1,957,314	1,097,[illegible]
1872–'73	3,930,508	2,679,986	1,201,127
1873–'74	4,170,388	2,840,981	1,305,[illegible]
1874–'75	3,827,845	2,684,708	1,193,[illegible]
1875–'76	4,632,313	3,252,994	1,356,[illegible]
1876–'77	4,474,069	3,049,497	1,426,41[illegible]
1877–'78	4,773,865	3,346,640	1,546,[illegible]
1878–'79	5,074,155	3,467,565	1,568,[illegible]
1879–'80	5,761,252	3,885,021	1,[illegible]
1880–'81	6,589,329	4,596,279	1,891,[illegible]
1881–'82	5,435,845	[illegible]595,031	1,[illegible]
Total	63,377,375	46,892,528	21,484,210

ACREAGE.

The acreage of cotton has been estimated by the Department of Agriculture, and in 1880 a census of the area of 1879 was taken as a part

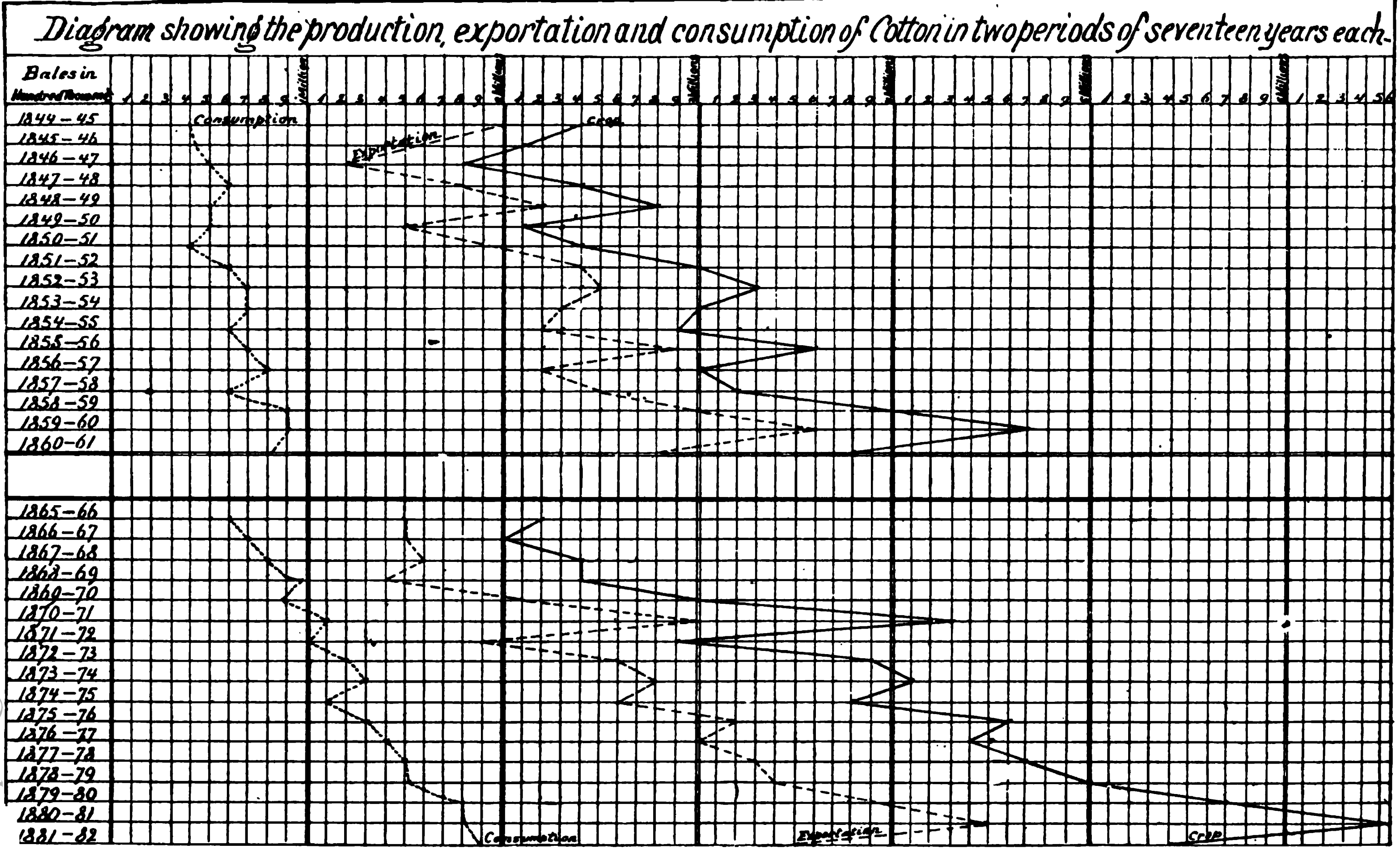


Diagram showing the production, exportation and consumption of Cotton in two periods of seventeen years each.
Bales in Hundred Thousands
1844-45
1845-46
1846-47
1847-48
1848-49
1849-50
1850-51
1851-52
1852-53
1853-54
1854-55
1855-56
1856-57
1857-58
1858-59
1859-60
1860-61
1865-66
1866-67
1867-68
1868-69
1869-70
1870-71
1871-72
1872-73
1873-74
1874-75
1875-76
1876-77
1877-78
1878-79
1879-80
1880-81
1881-82
Consumption
Exportation
Crop

of the work of the Census of the United States. It was taken so thoroughly, and revised so minutely, farm by farm, that there is scarcely a chance of material error. The following statement includes the census returns of area of 1879, and estimates for the recent years.

The present statistician made the annual estimates of acreage on the basis of returns from a large part of the area up to 1877, when the estimated area was 12,600,000 acres. In 1879 he estimated (unofficially) the breadth at 14,500,000 acres. The census afterwards made it 14,462,431 acres for the same year.

As the acreage of cotton, by counties, has never before been published, the local details of area and production in 1879, as returned by the census, are here given:

ALABAMA.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	2,330,086	699,654	Hale	69,995	18,093
			Henry	54,305	12,573
Autauga	30,474	7,944	Jackson	19,635	6,235
Baldwin	1,384	638	Jefferson	14,239	5,333
Barbour	100,442	26,062	Lamar	15,245	5,015
Bibb	15,737	4,943	Lauderdale	26,594	9,370
Blount	12,602	4,442	Lawrence	42,808	13,791
Bullock	80,470	22,578	Lee	51,889	13,189
Butler	35,851	11,895	Limestone	44,834	15,724
Calhoun	26,435	10,848	Lowndes	98,900	29,355
Chambers	70,934	19,476	Macon	56,763	14,580
Cherokee	24,388	10,777	Madison	72,838	20,679
Chilton	11,558	3,534	Marengo	80,790	23,481
Choctaw	31,086	9,054	Marion	7,369	2,240
Clarke	33,477	11,097	Marshall	16,412	5,368
Clay	13,921	4,973	Mobile	1	1
Cleburne	9,156	3,600	Monroe	33,463	10,421
Coffee	16,431	4,788	Montgomery	112,125	31,723
Colbert	25,411	9,012	Morgan	18,828	6,183
Conecuh	16,523	4,632	Perry	74,303	21,627
Coosa	26,468	8,411	Pickens	52,651	17,283
Covington	4,176	1,158	Pike	47,107	15,136
Crenshaw	26,962	8,173	Randolph	23,177	7,475
Cullman	1,469	378	Russell	61,592	19,442
Dale	27,076	6,224	Saint Clair	14,735	6,028
Dallas	115,631	33,534	Shelby	17,919	6,643
De Kalb	7,469	2,859	Sumter	80,662	22,211
Elmore	31,045	9,771	Talladega	32,841	11,832
Escambia	278	94	Tallapoosa	41,200	14,161
Etowah	15,187	6,571	Tuscaloosa	38,778	11,187
Fayette	12,331	4,368	Walker	8,743	2,754
Franklin	10,368	3,608	Washington	3,290	1,246
Geneva	4,947	1,112	Wilcox	77,076	26,745
Greene	63,643	15,811	Winston	2,048	568

ARKANSAS.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	1,042,976	608,256	Desha	21,159	18,103
			Dorsey	15,462	6,146
Arkánsas	12,611	8,506	Drew	21,796	9,964
Ashley	19,555	11,871	Faulkner	15,749	8,692
Baxter	4,798	2,879	Franklin	16,205	9,268
Benton	286	126	Fulton	3,994	2,438
Boone	5,095	2,686	Garland	993	534
Bradley	12,221	4,900	Grant	9,680	3,899
Calhoun	12,377	5,370	Greene	6,886	3,711
Carroll	982	502	Hemstead	27,142	13,985
Chicot	26,941	26,338	Hot Spring	8,068	3,755
Clark	25,092	13,924	Howard	12,259	7,051
Clay	4,239	2,307	Independence	19,602	11,156
Columbia	32,427	18,039	Izard	9,029	4,800
Conway	15,424	9,096	Jackson	21,718	13,895
Craighead	7,246	4,374	Jefferson	45,426	34,588
Crawford	16,145	8,980	Johnson	12,217	7,769
Crittenden	24,413	16,039	La Fayette	10,611	6,239
Cross	7,607	4,768	Lawrence	10,768	6,480
Dallas	14,306	6,157	Lee	33,009	21,147

ARKANSAS—Continued.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
Lincoln	17,519	11,568	Pope	15,062	3,709
Little River	10,868	7,116	Prairie	12,124	6,977
Logan	16,377	9,752	Pulaski	29,097	20,428
Lonoke	20,910	11,704	Randolph	11,028	6,248
Madison	255	129	Saint Francis	11,857	5,908
Marion	7,116	3,925	Saline	8,846	5,073
Miller	19,111	11,643	Scott	8,867	4,856
Mississippi	13,226	10,430	Searcy	4,320	2,464
Monroe	22,017	14,106	Sebastian	19,722	11,112
Montgomery	3,512	1,819	Sevier	7,283	4,073
Nevada	23,925	10,520	Sharp	8,455	4,359
Newton	2,602	1,496	Stone	3,656	2,048
Ouachita	23,855	8,849	Union	30,136	11,011
Perry	5,082	3,314	Van Buren	7,024	3,377
Phillips	42,654	29,070	Washington	302	128
Pike	7,341	3,787	White	23,304	11,821
Poinsett	2,378	1,514	Woodruff	18,124	12,311
Polk	4,230	2,061	Yell	16,596	10,428

FLORIDA.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	245,595	54,997	Leon	42,968	9,[illegible]
			Levy	3,665	1,251
Alachua	14,646	2,519	Liberty	734	197
Baker	1,107	215	Madison	28,962	7,654
Bradford	5,836	1,094	Marion	13,306	3,426
Brevard	6	2	Nassau	196	53
Calhoun	731	172	Orange	818	143
Clay	456	96	Polk	481	95
Columbia	13,142	1,992	Putnam	1,356	347
Duval	57	23	Saint John's	8	6
Escambia	25	10	Santa Rosa	17	5
Gadsden	19,464	4,696	Sumter	2,527	419
Hamilton	11,680	1,908	Suwanee	7,286	1,177
Hernando	1,558	468	Taylor	1,998	418
Hillsborough	556	150	Volusia	330	62
Holmes	1,137	278	Wakulla	2,371	561
Jackson	28,920	6,144	Walton	1,437	382
Jefferson	37,500	10,368	Washington	1,677	603
La Fayette	472	107			

GEORGIA.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	2,617,138	814,441	Coweta	48,494	16,282
			Crawford	24,754	6,765
Appling	1,060	379	Dade	32	12
Baker	28,670	4,870	Dawson	2,180	850
Baldwin	27,832	7,921	Decatur	29,509	6,286
Banks	8,251	2,960	De Kalb	19,318	5,066
Bartow	21,960	10,111	Dodge	6,002	1,916
Berrien	5,583	2,008	Dooly	38,495	9,866
Bibb	20,724	5,858	Dougherty	40,996	9,736
Brooks	21,255	6,288	Douglas	9,526	4,080
Bryan	764	304	Early	20,552	4,270
Bullock	9,140	3,724	Echols	3,578	731
Burke	87,859	29,172	Effingham	1,767	666
Butts	20,755	6,829	Elbert	25,838	8,856
Calhoun	24,429	4,670	Emanuel	10,749	3,660
Camden	206	68	Fayette	21,767	7,131
Campbell	21,448	8,966	Floyd	30,615	14,545
Carroll	22,503	9,300	Forsyth	12,121	5,044
Catoosa	867	111	Franklin	16,901	5,728
Charlton	258	62	Fulton	10,038	4,365
Chatham	280	65	Gilmer	128	32
Chattahoochee	15,442	4,460	Glascock	8,175	2,685
Chattooga	12,906	5,247	Glynn	58	10
Cherokee	13,739	5,615	Gordon	8,666	3,301
Clarke	8,020	3,810	Greene	40,087	12,448
Clay	21,539	4,576	Gwinnett	27.549	11,810
Clayton	17,422	6,606	Habersham	1,762	597
Clinch	1,622	511	Hall	12,245	5,132
Cobb	27,250	13,092	Hancock	42,773	15,010
Coffee	1,825	591	Haralson	4,860	2,035
Colquitt	2,958	736	Harris	43,208	12,677
Columbia	25,302	8,313	Hart	14,923	5,604

GEORGIA—Continued.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
Heard	17,348	5,900	Pulaski	32,074	9,865
Henry	25,730	10,930	Putnam	35,819	9,678
Houston	72,611	19,000	Quitman	11,815	3,163
Irwin	1,800	595	Rabun	45	14
Jackson	24,874	9,482	Randolph	34,204	8,467
Jasper	27,606	6,741	Richmond	7,871	2,742
Jefferson	41,367	13,377	Rockdale	14,448	4,385
Johnson	11,705	3,323	Schley	10,143	4,945
Jones	29,820	8,297	Screven	21,716	8,166
Laurens	20,689	6,868	Spalding	22,935	7,418
Lee	35,694	9,143	Stewart	44,449	12,658
Liberty	2,084	679	Sumter	44,190	11,451
Lincoln	12,798	3,861	Talbot	36,310	10,325
Lowndes	17,604	4,981	Taliaferro	14,058	4,758
Lumpkin	269	109	Tattnall	2 618	964
McDuffee	24,819	7,439	Taylor	18,064	4,854
McIntosh	339	104	Telfair	2,228	740
Macon	31,687	8,334	Terrell	25,740	6,944
Madison	13,029	4,918	Thomas	35,895	8,773
Marion	21,579	6,169	Troup	66,188	18,655
Meriwether	49,676	15,154	Twiggs	28,671	8,217
Miller	8,980	1,905	Union	12	5
Milton	9,989	4,490	Upson	30,551	8,540
Mitchell	30,265	5,559	Walker	5,797	2,009
Monroe	44,979	13,334	Walton	31,797	12,524
Montgomery	2,356	852	Ware	524	158
Morgan	35,243	7,358	Warren	24,991	7,885
Murray	5,937	1,917	Washington	66,900	23,068
Muscogee	11,635	3,268	Wayne	331	119
Newton	27,801	7,796	Webster	17,235	4,642
Oconee	12,303	4,257	White	228	66
Oglethorpe	35,306	12,336	Whitfield	4,068	1,240
Paulding	16,158	7,352	Wilcox	5,278	1,331
Pickens	2,210	734	Wilkes	30,891	11,109
Pierce	994	369	Wilkinson	25,423	7,966
Pike	38,755	12,431	Worth	12,157	2,898
Polk	16,774	8,126			

INDIAN TERRITORY.

The Territory	35,000	17,000			

KENTUCKY.

The State	2,667	1,367	Jefferson	110	48
			Laurel	3	1
Allen	3	2	Letcher	2	2
Ballard	31	15	Livingston	2	1
Barren	16	7	Logan	22	11
Bell	2	1	McCracken	33	18
Bracken	10	5	Magoffin	4	4
Butler	2	1	Marshall	23	10
Calloway	316	165	Muhlenburgh	4	4
Christian	2	1	Pendleton	12	9
Crittenden	11	4	Pike	16	9
Daviess	8	9	Pulaski	2	1
Edmonson	8	4	Simpson	5	3
Estill	8	2	Trigg	8	6
Floyd	12	2	Trimble	30	15
Fulton	549	300	Warren	31	10
Graves	869	417	Wayne	36	14
Green	2	1	Whitley	1	1
Henderson	21	9	Wolfe	2	1
Hickman	451	254			

LOUISIANA.

Parishes.	Acres.	Bales.	Parishes.	Acres.	Bales.
The State	864, 787	508, 569	Morehouse	28, 590	22, 481
			Natchitoches	26, 784	15, 329
Ascension	1, 285	592	Orleans	7	12
Assumption	285	119	Ouachita	28, 040	18, 729
Avoyelles	23, 722	18, 355	Point Coupée	24, 136	18, 975
Bienville	18, 242	7, 208	Rapides	25, 622	17, 900
Bossier	37, 133	25, 078	Red River	19, 200	11, 512
Caddo	46, 238	20, 963	Richland	15, 809	11, 631
Calcasieu	1, 493	514	Sabine	5, 932	2, 313
Caldwell	9, 919	6, 504	Saint Bernard	248	146
Cameron	1, 662	636	Saint Charles	51	47
Catahoula	15, 885	11, 766	Saint Helena	13, 626	5, 325
Claiborne	46, 567	19, 568	Saint Landry	42, 135	23, 148
Concordia	42, 044	33, 110	Saint Martin	6, 943	2, 223
De Soto	37, 807	11, 298	Saint Tammany	225	103
East Baton Rouge	11, 808	5, 756	Tangipahoa	7, 682	2, 904
East Carroll	40, 167	28, 160	Tensas	50, 555	41, 850
East Feliciana	28, 368	11, 098	Union	28, 308	11, 682
Franklin	12, 563	8, 472	Vermillion	2, 379	537
Grant	11, 155	5, 158	Vernon	4, 791	1, 662
Iberia	7, 443	2, 482	Washington	6, 371	2, 338
Iberville	771	579	Webster	16, 401	6, 256
Jackson	10, 138	3, 753	West Baton Rouge	3, 784	2, 426
La Fayette	12, 517	3, 489	West Carroll	5, 517	4, 012
Lincoln	22, 990	9, 723	West Feliciana	21, 072	11, 810
Livingston	3, 876	1, 344	Winn	7, 379	3, 062
Madison	28, 103	23, 391			

MISSISSIPPI.

The State	2, 093, 330	955, 808	Lincoln	17, 272	6, 296
			Lowndes	64, 670	21, 886
Adams	32, 117	19, 026	Madison	56, 393	21, 538
Alcorn	18, 803	7, 477	Marion	4, 717	1, 579
Amite	27, 749	9, 952	Marshall	67, 411	26, 441
Attala	35, 950	15, 285	Monroe	71, 402	23, 830
Benton	22, 401	8, 123	Montgomery	24, 636	10, 341
Bolivar	43, 330	36, 419	Neshoba	14, 021	4, 477
Calhoun	19, 028	9, 536	Newton	19, 589	6, 341
Carroll	37, 957	17, 423	Noxubee	82, 483	25, 294
Chickasaw	38, 477	12, 861	Oktibbeha	29, 679	9, 929
Choctaw	13, 497	5, 757	Panola	67, 060	30, 055
Claiborne	33, 121	18, 518	Perry	537	146
Clarke	15, 936	4, 693	Pike	19, 842	6, 507
Clay	41, 656	13, 137	Pontotoc	21, 448	8, 065
Coahoma	32, 964	26, 287	Prentiss	18, 610	7, 307
Copiah	54, 616	23, 726	Quitman	3, 420	2, 337
Covington	6, 968	2, 071	Rankin	30, 151	11, 775
De Soto	60, 488	28, 469	Scott	16, 293	6, 277
Franklin	18, 211	8, 042	Sharkey	17, 041	14, 162
Greene	35	12	Simpson	8, 855	3, 501
Grenada	25, 390	10, 228	Smith	10, 543	3, 721
Harrison	26	11	Sumner	13, 613	6, 236
Hinds	80, 013	36, 684	Sunflower	7, 107	5, 707
Holmes	62, 556	30, 463	Tallahatchie	22, 463	11, 570
Issaquena	18, 293	16, 150	Tate	48, 245	22, 683
Itawamba	14, 851	5, 113	Tippah	18, 738	7, 424
Jasper	20, 305	6, 228	Tishomingo	7, 555	2, 673
Jefferson	32, 141	18, 512	Tunica	16, 996	10, 705
Jones	2, 794	624	Union	21, 255	8, 230
Kemper	28, 269	8, 426	Warren	34, 127	22, 950
La Fayette	35, 309	15, 214	Washington	63, 409	54, 873
Lauderdale	32, 373	9, 350	Wayne	7, 550	1, 979
Lawrence	17, 806	5, 967	Wilkinson	23, 720	16, 030
Leake	24, 000	9, 016	Winston	15, 081	5, 864
Lee	38, 578	14, 406	Yalobusha	30, 398	12, 989
Le Flore	17, 730	11, 925	Yazoo	83, 184	46, 321

MISSOURI.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	32,116	20,318	New Madrid	2,518	1,649
			Oregon	1,848	1,128
Barry	4	2	Osage	10	5
Bollinger	29	20	Ozark	1,500	800
Butler	445	235	Pemiscot	3,787	2,848
Carter	3	1	Perry	2	1
Cedar	3	2	Reynolds	1	1
Christian	5	2	Ripley	866	471
Dallas	4	2	Scott	294	165
Douglas	12	5	Stoddard	5,576	3,203
Dunklin	11,100	7,361	Stone	700	400
Hickory	9	5	Taney	1,300	700
Howell	1,800	1,075	Washington	10	6
Laclede	43	20	Wayne	19	13
Miller	5	2	Wright	8	5
Mississippi	213	133			

NORTH CAROLINA.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	893,153	389,598	Jones	8,463	4,078
			Lenoir	19,150	8,235
Alamance	211	91	Lincoln	7,442	2,945
Alexander	617	182	McDowell	23	9
Anson	28,296	11,857	Madison	12	4
Beaufort	11,783	6,021	Martin	13,444	6,383
Bertie	19,455	7,290	Mecklenburgh	41,343	19,129
Bladen	1,018	683	Mitchell	15	6
Brunswick	385	244	Montgomery	6,519	2,989
Burke	752	361	Moore	8,882	3,988
Cabarrus	19,224	7,467	Nash	25,768	12,567
Caldwell	30	12	New Hanover	142	66
Camden	2,670	823	Northampton	36,219	13,616
Carteret	2,936	1,014	Onslow	6,658	2,841
Caswell	6	4	Orange	5,290	1,919
Catawba	5,175	2,012	Pamlico	4,585	2,226
Chatham	13,478	5,858	Pasquotank	4,004	1,181
Chowan	6,047	2,223	Pender	1,463	835
Cleveland	19,238	6,126	Perquimans	7,025	2,778
Columbus	2,113	930	Person	2	1
Craven	12,838	5,782	Pitt	31,147	14,879
Cumberland	9,210	3,905	Polk	1,646	368
Currituck	316	139	Randolph	595	295
Dare	16	8	Richmond	25,198	12,754
Davidson	3,779	1,553	Robeson	21,607	8,846
Davie	790	302	Rockingham	5	3
Duplin	9,654	4,499	Rowan	10,645	4,881
Edgecombe	51,880	26,250	Rutherford	9,679	2,079
Forsyth	16	10	Sampson	15,346	6,291
Franklin	30,274	12,938	Stanley	5,878	2,475
Gaston	10,949	4,588	Stokes	13	7
Gates	5,707	1,863	Surry	3	1
Granville	6,559	2,535	Tyrrell	2,481	1,123
Greene	16,988	8,020	Union	19,090	8,896
Guilford	283	114	Wake	59,916	30,115
Halifax	43,206	16,661	Warren	21,608	7,778
Harnett	9,281	3,627	Washington	8,117	3,524
Henderson	10	4	Watauga	10	3
Hertford	14,605	6,360	Wayne	32,103	14,558
Hyde	2,518	718	Wilkes	107	29
Iredell	11,003	4,657	Wilson	28,706	13,049
Jackson	16	6	Yadkin	87	36
Johnston	32,198	15,151			

SOUTH CAROLINA.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	1, 364, 249	522, 548	Horry	1, 773	[illegible]
			Kershaw	28, 978	11, 2[illegible]
Abbeville	83, 538	26, 380	Lancaster	30, 744	12, 667
Aiken	37, 018	14, 834	Laurens	63, 956	24, 484
Anderson	61, 060	21, 897	Lexington	22, 871	8, 950
Barnwell	83, 463	28, 764	Marion	45, 520	21, 748
Beaufort	11, 570	2, 740	Marlborough	41, 251	23, 785
Charleston	24, 802	9, 303	Newberry	57, 447	24, 155
Chester	52, 824	19, 051	Oconee	13, 596	3, 818
Chesterfield	18, 480	7, 783	Orangeburgh	61, 354	24, 492
Clarendon	26, 687	8, 589	Pickens	18, 463	5, 736
Colleton	11, 447	4, 869	Richland	28, 343	10, 956
Darlington	60, 404	23, 946	Spartanburgh	61, 237	24, 186
Edgefield	98, 797	35, 894	Sumter	57, 958	22, 109
Fairfield	69, 807	25, 729	Union	54, 209	19, 695
Georgetown	362	160	Williamsburgh	15, 898	5, 627
Greenville	45, 572	17, 064	York	58, 546	23, 825
Hampton	21, 624	7, 711			

TENNESSEE.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	722, 562	330, 621	Lake	3, 249	2, 412
			Lauderdale	24, 063	13, 2[illegible]
Anderson	60	38	Lewis	229	1[illegible]
Bedford	2, 239	940	Lawrence	1, 830	7[illegible]
Benton	4, 928	1, 801	Lincoln	8, 868	3, 486
Blount	198	70	Loudon	8	4
Bradley	51	15	McMinn	80	22
Campbell	4	1	McNairy	23, 135	9, 419
Cannon	77	35	Macon	4	1
Carroll	24, 711	10, 505	Madison	45, 825	18, 257
Cheatham	5	2	Marion	80	35
Claiborne	13	5	Marshall	4, 697	1, 723
Clay	2	1	Maury	21, 748	8, 912
Cocke	8	5	Meigs	36	14
Coffee	55	20	Monroe	129	73
Crockett	17, 807	9, 320	Montgomery	2	2
Davidson	3, 224	1, 383	Moore	20	7
Decatur	5, 591	2, 169	Morgan	4	1
De Kalb	26	12	Obion	7, 269	4, 225
Dickson	31	13	Overton	86	41
Dyer	14, 637	8, 564	Perry	452	196
Fayette	92, 231	39, 221	Polk	116	36
Fentress	6	2	Putnam	14	4
Franklin	414	171	Rhea	9	4
Gibson	36, 820	19, 272	Roane	35	18
Giles	31, 416	13, 802	Rutherford	32, 657	12, 414
Grainger	59	36	Scott	2	2
Greene	3	1	Sevier	10	6
Grundy	32	21	Shelby	92, 630	46, 336
Hamblen	12	2	Stewart	45	15
Hamilton	486	143	Sumner	732	317
Hardeman	44, 885	18, 937	Tipton	38, 429	21, 415
Hardin	12, 859	5, 345	Trousdale	1	1
Hawkins	2	2	Union	2	1
Haywood	49, 919	23, 092	Van Buren	86	29
Henderson	22, 844	9, 419	Warren	206	96
Henry	13, 186	5, 516	Wayne	2, 365	1, 367
Hickman	3, 128	1, 302	Weakley	15, 406	7, 576
Houston	8	4	White	898	139
Humphreys	155	90	Williamson	11, 880	4, 536
Jackson	56	28	Wilson	3, 191	1, 373
Knox	11	7			

TEXAS.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	2,173,732	803,642	Jasper	4,455	1,410
			Jefferson	133	77
Anderson	23,725	7,548	Johnson	40,446	13,778
Angelina	5,681	2,319	Jones	81	19
Archer	104	43	Karnes	1,607	283
Atascosa	1,422	469	Kaufman	26,659	10,668
Austin	31,321	13,185	Kendall	1,808	286
Bandera	223	52	Kerr	469	72
Bastrop	35,730	14,714	Lamar	40,390	24,623
Baylor	326	83	Lampasas	4,611	628
Bee	44	9	Lavaca	25,728	9,976
Bell	37,826	9,217	Lee	15,662	5,526
Bexar	4,273	1,548	Leon	23,578	7,360
Blanco	3,039	690	Liberty	3,768	1,852
Bosque	19,624	8,833	Limestone	35,519	9,037
Bowie	11,509	7,958	Live Oak	16	4
Brazoria	5,402	3,484	Llano	2,247	469
Brazos	28,044	9,743	McCulloch	145	54
Brown	4,254	998	McLennan	53,394	12,777
Burleson	15,298	5,965	Madison	9,158	2,656
Burnet	7,024	1,399	Marion	17,102	7,515
Caldwell	18,906	7,609	Mason	262	64
Callahan	434	86	Matagorda	3,485	2,006
Cameron	25	23	Medina	685	289
Camp	11,473	5,680	Milam	37,473	10,844
Cass	34,822	16,181	Montague	10,947	4,172
Chambers	140	91	Montgomery	13,811	4,092
Cherokee	29,708	9,813	Morris	10,650	4,890
Clay	3,289	1,155	Nacogdoches	16,762	4,791
Coleman	796	243	Navarro	45,716	12,958
Collin	48,236	22,145	Newton	3,510	1,323
Colorado	32,994	15,552	Orange	66	22
Comal	5,860	2,102	Palo Pinto	4,292	885
Comanche	9,301	2,098	Panola	23,777	8,703
Cooke	27,795	11,547	Parker	15,036	4,454
Coryell	19,688	3,331	Polk	7,229	3,629
Dallas	44,377	21,469	Rains	4,399	1,915
Delta	8,940	4,911	Red River	31,291	17,669
Denton	29,785	11,568	Refugio	36	15
De Witt	7,625	2,183	Robertson	49,854	18,080
Eastland	3,264	742	Rockwall	5,786	2,630
Ellis	52,172	18,956	Rusk	38,326	11,145
Erath	14,220	2,857	Sabine	5,252	1,705
Falls	39,669	12,495	San Augustine	7,219	2,757
Fannin	44,813	22,386	San Jacinto	9,840	5,354
Fayette	58,358	24,766	San Patricio	6	2
Fort Bend	10,878	6,431	San Saba	2,819	400
Franklin	8,660	4,048	Shackelford	23	5
Freestone	31,872	8,182	Shelby	16,136	6,171
Frio	543	156	Smith	45,703	16,285
Galveston	289	136	Somerville	4,030	1,066
Gillespie	4,082	707	Stephens	686	137
Goliad	1,779	728	Tarrant	27,821	10,950
Gonzales	22,729	7,511	Throckmorton	51	10
Grayson	41,339	19,166	Titus	9,395	4,923
Gregg	13,767	4,590	Travis	29,500	9,271
Grimes	35,984	11,701	Trinity	6,802	2,666
Guadalupe	16,409	6,531	Tyler	5,504	2,548
Hamilton	6,840	1,147	Upshur	19,418	8,023
Hardin	264	103	Uvalde	141	53
Harris	4,440	1,892	Van Zandt	17,579	6,957
Harrison	46,614	17,619	Victoria	1,739	730
Hays	9,848	3,441	Walker	20,162	6,441
Henderson	15,763	6,159	Waller	10,104	3,923
Hidalgo	24	9	Washington	58,705	20,692
Hill	38,535	8,369	Wharton	5,563	3,182
Hood	7,139	1,966	Wichita	103	43
Hopkins	19,242	8,279	Williamson	18,528	4,217
Houston	26,819	9,730	Wilson	5,814	1,874
Hunt	25,906	10,805	Wise	21,352	7,231
Jack	4,751	1,444	Wood	15,486	7,381
Jackson	648	202	Young	2,049	554

VIRGINIA.

Counties.	Acres.	Bales.	Counties.	Acres.	Bales.
The State	45,040	19,595	King and Queen	80	20
			Mecklenburgh	2,150	975
Brunswick	6,800	2,950	Nansemond	1,960	800
Dinwiddie	6,500	2,500	Prince George	1,900	700
Greenville	8,500	4,100	Southampton	11,500	5,200
Isle of Wight	850	400	Sussex	4,800	1,950

RECAPITULATION BY STATES, WITH AVERAGE YIELD PER ACRE.

States.	Acres.	Bales.	Bales per acre.	States.	Acres.	Bales.	Bales per acre.
Total United States	14, 462, 481	5, 746, 414	0. 40	Louisiana..........	864. 787	508, 569	0. 59
				Mississippi	2, 093, 330	855, 808	0. 41
Alabama	2, 330, 086	699, 654	0. 30	Missouri..........	32, 116	20, 318	0. 63
Arkansas..........	1, 042, 976	608. 256	0. 58	North Carolina ...	893, 153	389, 598	0. 44
Florida	245, 595	54, 997	0. 22	South Carolina....	1, 364, 249	522, 548	0. 38
Georgia	2, 617, 138	814, 441	0. 31	Tennessee	722, 562	310, 621	0. 44
Indian Territory...	35, 000	17, 000	0. 49	Texas	2, 173, 732	803, 642	0. 37
Kentucky	2, 667	1, 367	0. 51	Virginia	45, 040	19, 595	0. 44

INCREASE OF PRODUCTION OF CEREALS.

In considering the increase in the production of cereals, especially in comparison with European production, it should be remembered that a very large proportion is fed to farm animals in this country, and in Europe a very small proportion. Roots, beet-pulp, oil-cake, and other products, in so general use there, find here a substitute in maize and oats. Rye is the bread grain of the central and eastern countries of the continent, as wheat is in the United States. We find, therefore, in the census year, sixty-five per cent. of the cereals represented by maize, and fifteen by oats, four-fifths of all the cereals produced. Rye, barley, and buckwheat, scarcely three per cent. of the volume, are used mostly for bread, beer, and whisky, so that corn and oats constitute the grain supplies of farm animals. The use of cereals in this country for food of man can be very closely approximated. At present the proportion so used (exclusive of seed) is very nearly one-fourth, farm animals consuming three-fourths. This fact accounts for the extraordinary increase in production of corn and oats. The largest percentage of increase has been in barley, as the consumption of beer has increased in greater ratio than that of bread or meats.

The following table shows the increase in each kind of grain, the percentage of such increase for thirty years, and the proportion of the last census crop of each kind of grain expressed as a percentage of the whole:

Products.	1849.	1859.	1869.	1879.		
				Bushels.	Increase in thirty years.	Per cent. of all cereals.
	Bushels.	*Bushels.*	*Bushels.*		*Per cent.*	
Corn..............	592, 071, 104	838, 792, 742	760, 944, 549	1, 754, 861, 535	196	65. 04
Wheat.............	100, 485, 944	173, 104, 924	287, 745, 626	459, 479, 505	357	17. 03
Oats	146, 584, 179	172, 643, 185	282, 107, 157	407, 858, 999	178	15 11
Rye	14, 188, 813	21, 101, 380	16, 918, 795	19, 831, 595	40	.74
Barley	5, 167, 015	15, 825, 898	29, 761, 305	44, 113, 495	753	1. 64
Buckwheat	8, 956, 912	17, 571, 818	9, 821, 721	11, 817, 327	32	.44
Total	867, 453, 962	1, 239, 039, 947	1, 387, 299, 158	2, 697, 962, 456	211	100. 00

Consumption and exportation.—The exportation of recent years has been extraordinary, quite unprecedented in the history of any nation. It has excited so much attention that the public is in danger of failing to notice that the increase of consumption in thirty years is five times as much as the enlargement of exportation. The volume of consumption is three times as large as in 1850. The grain spared to meet the necessities of foreigners, in three years past, has reached an astonishing figure, and realized a far larger sum in foreign exchange than cotton in the same period; yet it has been less than a tenth of the production of cereals in the same three years. The largest exportation ever made was of the crop of 1879 and 1880, 10.5 per cent. of the former, and 10.4 per cent. of the latter, while in 1881 it was only 8.1 per cent. of the greatly reduced production of that year. It is worthy of thoughtful consideration that while population has increased little more than 100 per cent. the means of subsistence have increased nearly 200 per cent.; that we are able to export nearly twice as much wheat as was produced thirty years ago. This exportation is mostly of wheat and corn; of the former from a third to four-tenths of the crop, and of the latter never exceeding 6 per cent. Wheat is the only grain the price of which is much affected by the foreign demand. A comparison of domestic and foreign consumption is afforded by the following tables:

Cereals.	Production.	Consumption.		Exportation.	
	Bushels.	*Bushels.*	*Per cent.*	*Bushels.*	*Per cent.*
1879.					
Corn	1,754,861,535	1,655,289,206	94.3	99,572,329	5.7
Wheat	459,479,505	279,075,325	60.7	180,404,180	39.3
Oats	407,858,999	407,092,633	99.9	766,366	0.1
Barley	44,113,495	42,984,572	97.4	1,128,923	2.6
Rye	19,831,595	16,895,491	85.2	2,936,104	14.8
Buckwheat	11,817,327	11,817,327	100	....	....
Total	2,697,962,456	2,413,154,554	....	284,807,902	10.5
1880.					
Corn	1,717,434,543	1,623,786,396	94.5	93,648,147	5.5
Wheat	498,549,868	312,228,354	62.6	186,321,514	37.4
Oats	417,885,380	417,482,476	99.9	402,904	0.1
Barley	45,165,346	44,280,100	98	885,246	2
Rye	24,540,829	22,592,354	92.1	1,948,475	7.9
Buckwheat	14,617,535	14,617,535	100	....	....
Total	2,718,193,501	2,434,987,215	....	283,206,286	10.4
1881.					
Corn	1,194,916,000	1,150,575,317	96.3	44,340,683	3.7
Wheat	383,280,090	261,387,701	68.2	121,892,389	31.8
Oats	416,481,000	415,855,310	99.9	625,690	00.1
Barley	41,161,330	40,955,400	99.5	205,930	00.5
Rye	20,704,950	19,708,763	95.2	996,187	4.8
Buckwheat	9,486,200	9,486,200	100	....	....
Total	2,066,029,570	1,897,968,691	....	168,060,879	8.0

The average exportation of wheat for four years, since the annual shipments reached one hundred million bushels, is 159,051,433 bushels, or 37.5 per cent. of the four crops. The average quantity of corn exported in the same time is 81,361,513 bushels, or 5.4 per cent. of the production. The volume of exports of wheat have doubled in five years; of corn, in six years. The progress of this foreign trade is thus shown in five-year periods:

Year.	Wheat.	Corn.
	Bushels.	*Bushels.*
1858-'62	161,537,194	44,131,907
1863-'67	144,662,741	58,000,490
1868-'72	194,449,856	69,321,237
1873-'77	339,278,305	229,728,387
1878-'82	726,373,691	806,297,478

Before dismissing the subject of foreign trade in grain, the facts of importation, which make a meager show except as to barley, may be seen in the following statement:

Years.	Corn.	Wheat.		Oats.	Rye.	Barley.	
	Bushels.	Bushels.	Barrels of flour.	Bushels.	Bushels.	Bushels.	Bushels of malt.
1872	58, 568	1, 546, 628	172, 823	535, 250	249, 146	5, 565, 591	283, 941
1873	61, 536	1, 476, 594	72, 891	225, 555	214, 102	4, 214, 751	278, 727
1874	76, 008	1, 646, 092	94, 137	191, 802	164, 153	4, 891, 189	245, 646
1875	38, 098	303, 047	12, 988	1, 500, 040	298, 642	6, 255, 063	144, 487
1876	51, 796	1, 568, 558	19, 116	121, 547	241, 291	10, 285, 957	396, 800
1877	30, 902	328, 906	7, 431	41, 597	98, 974	6, 702, 965	314, 129
1878	13, 423	1, 351, 008	7, 941	21, 391	430, 245	6, 764, 228	552, 656
1879	23, 869	2, 011, 291	12, 606	13, 395	477, 762	5, 720, 979	537, 995
1880	58, 876	462, 882	5, 161	489, 576	532, 585	7, 135, 258	1, 023, 447
1881	75, 155	200, 620	2, 296	64, 412	473, 925	9, 528, 616	685, 297

AVERAGE YIELD BY STATES.

In the census year 1879, which was a year of more than average yield, the common average of corn was 28.5 bushels per acre. All of the New England States, all of the Western (to the Rocky Mountains), New York, Pennsylvania, and New Jersey, were above that common average; all of the Southern States, and most of the States and Territories west of Nebraska, below average. Iowa stood in the first rank, followed in order by Nebraska, New Hampshire, Vermont, Missouri, and Illinois. The New England States stand higher than any other section. Fertilization and cultivation make amends for the lack of fertility.

Minnesota holds the first rank in wheat-growing as to quantity produced in proportion to population, the supply per head being 44.3 in the census year. Next, Oregon, 42.9; California, 33.6; Nebraska, 30.6; Washington, 25.6; Indiana, 23.9; Michigan, 21.7; Dakota, 20.9.

Only ten States east of the Rocky Mountains and two on the Pacific coast have any considerable surplus; and but two Territories, Dakota and Washington. The wheat belt lies west of the Alleghanies, and the Lakes and the Ohio River.

The northern border, as climatic conditions would indicate, furnishes the highest example of yield in the cultivation of oats, as well as the best results in quality. Washington Territory heads the list of oats-producing States, with a yield of 41.3 bushels; Minnesota, 37.9; Vermont, 37.6; Montana, 36.5; New Hampshire, 34.5; Wisconsin, 34.4; Michigan, 33.9. These are the highest yields, and they are all border States. New England as a section gives the highest average.

It is desirable to have a means of comparison of normal yields per acre of different States. The result in no single year would fairly represent the differences in productive capacity of States, yet 1879, as reported by the census of 1880, comes as near it as can be expected in any year. The average yields of the great grain-producing States, in 1879, were among the highest ever obtained in States which return the largest figures, higher than an average of a series of years would show. Keeping this fact in view, and also the local causes which reduced the normal yield in certain States, a table showing the average yield of each State will serve as a guide to the rate of production of each State:

Average yield per acre of corn and wheat, 1879.

States.	Corn.			Wheat.			Supply per capita.
	Acres.	Bushels.	Yield per acre.	Acres.	Bushels.	Yield per acre.	
Maine	30,907	960,693	31	43,829	665,714	15.2	1
New Hampshire	36,612	1,350,248	36.9	11,248	169,316	15	.5
Vermont	55,249	2,914,271	36.5	20,748	337,257	16.2	1
Massachusetts	53,344	1,797,593	33.7	963	15,768	16.4	......
Rhode Island	11,893	372,967	31.4	17	240	14.1	......
Connecticut	55,796	1,880,421	33.7	2,198	38,742	17.6	.6
New England States	243,891	5,376,133	34.3	79,003	1,227,037	15.5	.3
New York	779,272	25,875,480	33.2	736,611	11,587,766	15.7	2.3
New Jersey	344,555	11,150,705	32.4	149,760	1,901,739	12.7	1.7
Pennsylvania	1,373,270	45,821,531	33.4	1,445,384	19,462,405	13.5	4.5
Northern Middle States	2,497,097	82,847,716	33.2	2,331,755	32,951,910	14.1	3.1
Delaware	202,120	3,894,264	19.3	87,539	1,175,272	13.4	8
Maryland	664,928	15,968,533	24	569,296	8,004,864	14.1	8.6
Virginia	1,767,567	29,106,661	16.5	900,807	7,832,504	8.7	5.2
Southern Middle States	·,634,615	48,969,458	18.6	1,557,642	17,002,640	10.9	6.6
North Carolina	2,305,419	28,019,839	12.2	646,8·9	3,397,398	5.2	2.4
South Carolina	1,308,404	11,767,099	9	170,902	962,358	5.6	1
Georgia	2,58·,733	23,202,018	9	475,684	3,159,771	6.6	2
Florida	360,294	3,174,234	8.8	81	423	5.2	......
South Atlantic States	6,507,850	66,163,190	10.2	1,293,498	7,519,944	5.8	1.8
Alabama	2,055,929	25,451,278	12.4	264,971	1,529,657	5.7	1.2
Mississippi	1,570,550	21,340,800	13.6	43,524	218,890	5	......
Louisiana	742,728	9,906,180	13.3	1,501	5,034	3.4	......
Texas	2,468,587	29,065,172	11.8	373,612	2,567,760	6.8	1.6
Arkansas	1,298,310	24,156,417	18.6	204,131	1,269,730	6.2	1.6
Tennessee	2,904,873	62,764,429	21.6	1,196,563	7,331,353	6.1	4.8
Southern States	11,040,977	172,684,285	15.6	2,084,302	12,922,424	6.2	1.8
West Virginia	565,785	14,090,609	24.9	398,068	4,001,711	10.2	6.5
Kentucky	3,021,176	72,852,263	24.1	1,160,108	11,356,113	9.8	6.9
Ohio	3,281,923	111,877,124	34.1	2,556,134	46,014,869	18	14.4
Michigan	919,792	32,461,452	35.3	1,822,749	35,532,543	19.5	21.7
Indiana	3,678,420	115,482,300	31.4	2,619,695	47,284,853	18	23.9
Illinois	9,019,381	325,792,481	36.1	3,218,542	51,110,502	15.9	16.6
Wisconsin	1,015,393	34,230,579	33.7	1,948,160	24,884,689	12.8	18.9
Western States	21,501,870	706,786,808	32.9	13,718,456	220,185,280	16.1	16.2
Minnesota	438,737	14,831,741	33.8	3,044,670	34,601,030	11.4	44.3
Iowa	6,616,144	275,024,247	41.6	3,049,288	31,154,205	10.2	19.2
Missouri	5,588,265	202,485,723	36.2	2,074,394	24,966,627	12	11.5
Kansas	3,417,817	105,729,325	30.9	1,861,402	17,324,141	9.3	17.4
Nebraska	1,630,600	65,450,135	40.1	1,469,865	13,847,007	9.4	30.6
Colorado	22,991	455,968	19.8	64,693	1,425,014	22	7.8
Trans-Mississippi States	17,714,614	663,977,139	37.5	11,564,312	123,318,024	10.7	19.8
California	71,781	1,993,325	27.8	1,832,429	29,017,707	15.8	33.6
Oregon	5,646	126,862	22.5	445,077	7,480,010	16.8	42.9
Nevada	487	12,891	26.5	3,674	69,298	18.9	1.1
Pacific States	77,914	2,133,078	27.4	2,281,180	36,567,015	16.0	33.2
Arizona	1,818	34,746	19.1	9,026	136,427	15.1	3.3
Dakota	90,852	2,000,864	22.0	265,298	2,830,289	10.7	20.9
District of Columbia	1,032	29,750	28.8	284	6,402	22.5	.3
Idaho	569	16,408	28.8	22,066	540,549	24.5	16.6
Montana	197	5,649	28.7	17,665	469,688	26.6	12
New Mexico	41,449	633,786	15.3	51,230	706,641	13.8	5.9
Utah	12,007	163,342	13.6	72,542	1,160,199	16.0	8.1
Washington	2,117	39,183	18.5	81,554	1,921,322	23.4	25.6
Wyoming	......	......	......	241	4,674	19.4	.2
The Territories	150,041	2,923,728	19.5	519,906	7,785,231	15.0	9.9
Total States and Territories	62,368,869	1,754,861,535	28.1	35,430,050	459,479,504	13.0	9.2

Average yield per acre of oats and barley, 1879.

States.	Oats.			Barley.		
	Acres.	Bushels.	Yield per acre.	Acres.	Bushels.	Yield per acre.
Maine	78,785	2,265,575	28.8	11,106	242,185	21.8
New Hampshire	29,485	1,017,620	34.5	3,461	77,877	22.5
Vermont	99,548	3,742,282	37.6	10,559	267,626	25.4
Massachusetts	20,659	645,159	31.2	3,171	80,128	25.3
Rhode Island	5,575	159,339	28.6	715	17,783	24.9
Connecticut	36,691	1,009,706	27.5	575	12,286	21.4
New England States	270,743	8,839,681	32.6	29,580	697,884	23.6
New York	1,261,171	37,575,576	29.8	356,629	7,792,062	21.8
New Jersey	137,422	3,710,573	27	240	4,091	17
Pennsylvania	1,237,593	33,841,439	27.3	23,592	438,100	18.6
North Middle States	2,636,186	75,127,518	28.5	380,461	8,234,253	21.6
Delaware	17,158	378,508	22.1	19	523	27.5
Maryland	101,127	1,794,872	17.7	226	6,097	27
Virginia	563,443	5,333,181	9.5	859	14,223	16.6
South Middle States	681,728	7,506,561	11	1,104	20,843	18.9
North Carolina	500,415	3,838,068	7.7	230	2,421	10.5
South Carolina	261,445	2,715,595	10.4	1,162	16,257	14
Georgia	612,778	5,548,743	9.1	1,430	18,682	13
Florida	47,962	468,112	9.8	21	210	10
South Atlantic States	1,422,600	12,570,428	8.8	2,852	37,550	13.2
Alabama	324,628	3,039,639	9.4	511	5,281	10.3
Mississippi	198,497	1,959,620	9.9	44	348	7.9
Louisiana	26,461	229,840	8.6	......	......	......
Texas	238,010	4,893,359	20.6	5,527	72,786	13.2
Arkansas	166,513	2,219,822	13.3	157	1,952	12.4
Tennessee	468,566	4,722,190	10.1	2,600	30,019	11.5
Southern States	1,423,075	17,064,470	12	8,839	110,386	12.5
West Virginia	126,931	1,908,505	15	424	9,740	23
Kentucky	403,416	4,580,738	11.4	20,089	485,326	24.2
Ohio	910,888	28,664,505	31.5	57,482	1,707,129	29.7
Michigan	536,187	18,190,793	33.9	54,506	1,204,316	22.1
Indiana	623,531	15,509,518	25	16,399	382,835	23.3
Illinois	1,959,889	63,189,200	32.2	55,267	1,229,523	22.2
Wisconsin	955,597	32,905,320	34.4	204,335	5,043,118	24.7
Western States	5,515,939	165,038,579	29.9	408,502	10,062,987	24.6
Minnesota	617,460	23,382,158	37.9	116,020	2,972,965	25.6
Iowa	1,507,577	50,610,591	33.6	198,881	4,022,588	20.2
Missouri	968,473	20,670,958	21.1	6,472	123,031	19
Kansas	435,859	8,180,385	18.8	23,993	300,273	12.5
Nebraska	250,437	6,555,875	26.2	115,201	1,744,686	15.1
Colorado	23,028	640,900	27.8	4,112	107,116	26
Trans-Mississippi States	3,802,858	110,040,867	28.9	464,659	9,270,659	20
California	49,917	1,341,271	26.9	586,340	12,579,561	21.5
Oregon	151,624	4,385,650	28.9	29,311	920,977	31.4
Nevada	5,937	186,860	31.5	19,399	513,470	26.5
Pacific States	207,508	5,913,781	28.9	635,050	14,014,008	22.1
Utah	19,525	418,082	21.4	11,268	217,140	19.3
New Mexico	9,237	156,527	16.9	2,548	50,053	19.6
Washington	37,002	1,571,706	41.3	14,690	566,537	38.5
Dakota	78,226	2,217,132	28.3	16,156	277,424	17.1
Montana	24,691	900,915	36.5	1,323	39,970	30.2
Idaho	13,197	462,296	35	8,291	274,730	33.1
Arizona	29	564	19.4	12,404	239,051	19.3
Wyoming	822	22,512	27.4	......	......	......
District of Columbia	267	7,440	27.9	......	......	......
The Territories	183,956	5,757,114	31.3	66,670	1,064,925	25
Total States and Territories	16,144,593	407,858,999	25.3	1,997,717	44,113,495	22

Average yield per acre of rye and buckwheat, 1879.

States.	Rye. Acres.	Rye. Bushels.	Rye. Yield per acre.	Buckwheat. Acres.	Buckwheat. Bushels.	Buckwheat. Yield per acre.
Maine	2,161	26,398	12.2	20,135	382,701	19
New Hampshire	3,218	34,638	10.8	4,535	94,090	20.7
Vermont	6,319	71,733	11.4	17,649	356,618	20.2
Massachusetts	21,666	213,716	9.9	5,617	67,117	11.9
Rhode Island	1,270	12,997	10.2	105	1,254	11.9
Connecticut	29,794	370,733	12.4	11,231	137,563	12.2
New England States	64,428	730,215	11.3	59,272	1,039,343	17.5
New York	244,923	2,634,690	10.8	291,228	4,461,200	15.3
New Jersey	106,025	940,064	8.9	35,373	466,414	13.2
Pennsylvania	398,465	3,683,521	9.2	246,199	3,593,326	14.6
North Middle States	749,413	7,267,875	9.7	572,800	8,520,940	14.9
Delaware	773	5,953	7.7	397	5,857	14.8
Maryland	32,405	288,067	8.9	10,294	136,667	13.3
Virginia	48,746	324,431	6.7	16,463	136,004	8.3
South Middle States	81,924	618,451	7.5	27,154	278,528	10.3
North Carolina	61,953	285,160	4.6	5,725	44,668	7.8
South Carolina	7,152	27,049	3.8			
Georgia	25,854	101,716	3.9	58	402	6.9
Florida	601	2,965	4.9			
South Atlantic States	95,560	416,890	4.4	5,783	45,070	7.8
Alabama	5,834	28,402	4.9	42	363	8.6
Mississippi	806	5,134	6.4			
Louisiana	201	1,013	5			
Texas	3,326	25,399	7.6	48	535	11.1
Arkansas	3,290	22,387	6.8	92	548	5.9
Tennessee	32,493	156,419	4.8	4,907	33,434	6.8
Southern States	45,950	238,754	5.2	5,089	34,880	6.9
West Virginia	17,279	113,181	6.6	30,334	285,298	9.5
Kentucky	89,417	668,050	7.5	1,024	9,942	9.7
Ohio	29,499	389,221	13.2	22,130	280,229	12.7
Michigan	22,815	294,918	12.9	33,918	413,062	12.2
Indiana	25,400	303,105	11.9	8,846	89,707	10.1
Illinois	192,138	3,121,785	16.2	16,457	178,859	10.9
Wisconsin	169,692	2,298,513	13.5	34,117	290,107	8.8
Western States	546,240	7,188,773	13.2	146,856	1,550,204	10.6
Minnesota	13,614	215,245	15.8	3,677	41,758	11.4
Iowa	102,607	1,518,605	14.8	16,318	166,895	10.2
Missouri	46,484	535,426	11.5	5,463	57,640	10.5
Kansas	34,621	413,181	11.9	2,458	24,421	9.9
Nebraska	34,297	424,348	12.4	1,666	17,562	10.5
Colorado	1,294	19,465	15	8	110	13.7
Trans-Mississippi States	232,917	3,126,270	13.4	29,590	308,384	10.4
California	20,281	181,681	9	1,012	22,307	22
Oregon	841	13,305	15.8	372	6,215	16.7
Nevada						
Pacific States	21,122	194,986	9.2	1,384	28,522	20.6
Utah	1,153	9,605	8.3			
New Mexico	17	240	14.1			
Washington	518	7,124	13.8	106	2,498	23.6
Dakota	2,385	24,359	10.2	321	2,521	7.9
Montana	15	430	28.7	34	437	12.9
Idaho	354	4,341	12.3			
Arizona						
Wyoming	6	78	13			
District of Columbia	301	3,704	12.3			
The Territories	4,749	49,881	10.5	461	5,456	11.8
Total States and Territories	1,842,303	19,831,593	10.8	848,389	11,817,327	12.8

SEEDING OF WHEAT.

In an investigation concerning the methods of seeding winter wheat, it is shown how widely the time of sowing or drilling varies in the range of latitude from 30° to 42°, covering a period of four months from August 1 to December 31. In California exceptional conditions exist, and, except in cases where summer fallowing is practiced, seeding must wait for the rains to soften the ground, and continues nearly or quite through the rainy season, say from November to February.

In the Middle and Western States wheat-growers commence drilling in the latter part of August; in the Gulf States, September is early, and the work may be done, at the convenience or preference of the farmer, during the autumn until Christmas. The length of the seeding season is greatest in the most southern latitudes; in Texas its extreme duration is from September 1 to March 15, admitting of planting during the entire fall and winter. The average or middle date, representing the seeding of half the breadth, is the 16th of September in New York, the 20th in Pennsylvania, and 28th in New Jersey. Delaware, Maryland, Virginia, North Carolina, Kentucky, Tennessee, and Arkansas find their average date in October; Georgia and all the Gulf States in November. The table showing the time of seeding and proportion drilled is as follows:

States.	Date of seeding.	Average date of seeding.	Drilled.	Broadcasted.
			Per cent.	*Per cent.*
Connecticut	September 1 to November 1	Sept. 25	5	95
New York	August 15 to October 30	Sept. 16	52	48
New Jersey	August 28 to November 10	Sept. 28	56	44
Pennsylvania	August 20 to October 20	Sept. 20	70	30
Delaware	September 20 to October 10	Oct. 1	75	25
Maryland	September 1 to December 1	Oct. 13	63	37
Virginia	August 20 to November 25	Oct. 15	30	70
North Carolina	September 1 to January 10	Oct. 29	*8	92
South Carolina	October 1 to January 1	Nov. 1	1	99
Georgia	September 1 to January 10	Nov. 2	2	98
Alabama	September 1 to December 20	Nov. 3	6	94
Mississippi	September 1 to December 1	Nov. 3	1	99
Louisiana	September 1 to November 20	Nov. 5	1	99
Texas	September 1 to March 15	Nov. 7	11	89
Arkansas	September 1 to January 15	Oct. 26	2	98
Tennessee	August 1 to December 15	Oct. 15	15	85
West Virginia	August 20 to November 15	Sept. 30	40	60
Kentucky	August 25 to December 20	Oct. 7	31	69
Ohio	August 1 to November 20	Sept. 20	78	22
Michigan	August 20 to November 15	Sept. 17	52	48
Indiana	August 15 to November 15	Sept. 19	81	19
Illinois	August 20 to November 10	Sept. 20	71	29
Missouri	August 15 to December 1	Sept. 25	58	42
Kansas	August 1 to January 1	Sept. 23	73	27

PROPORTION OF DRILLED AND ADVANTAGES OF DRILLING.

The area seeded with the drill amounts to 57 per cent., or fourteen million acres in the above-named States, leaving above ten million acres sown broadcast, and mainly by hand. In the spring wheat region of the Northwest the drill is less used, though its use is increasing. The broadcast seeder is also employed to facilitate the work, yet much of the acreage is sown by hand in the old-fashioned style. On the Pacific coast the drill has a limited use.

The question of drilling or broadcasting is virtually one of good or bad husbandry. Where the soil is in good tilth, high fertility, and free from such obstructions as rocks or stumps, the preference expressed is almost invariably for drilling. In those districts in which custom follows corn with wheat, the corn is cut and stooked early, the shaded soil is moist, and after stirring surface and breaking weeds with harrow or cultivator, the seed is sown and soon comes up, and produces a fair growth. With preparation so hasty and superficial, drilling is impracticable, and broadcasting a necessity. So in the weedy wheat fields of primitive soils given year after year to wheat-growing; the land is cheap and labor dear, and the surface yearly becomes weedier, making drilling inconvenient and expensive. Then, there are wooded districts where stumps for some years prevent the use of the drill; and in eastern fields rocks are sometimes troublesome; while on steep mountain slopes, as in the Alleghanies, drilling is inconvenient and little practiced.

As to direction of drilling, some prefer drills running north and south, as a protection against western winds. In other locations east and west lines are preferred.

Of nearly seven hundred counties from which reports were received on this subject, preference was expressed for either drilling or broadcasting in three-fourths of them, and, as between the two modes, five of every six favored the use of the drill.

As a rule, those who preferred broadcasting gave no reasons for it, simply acquiescing in the prevailing custom of the region. A correspondent in Callahan County, Texas, asserts that "when broadcasting is properly done it is as good as drilling." The correspondent for Davis County, Utah, strikes the key-note of primitive western wheat-growing in commending "drilling when land is clear, and breadcasting when land is foul." One correspondent naively admits that he "can't tell why" he prefers broadcasting. The most plausible reason for broadcast sowing is given in some flat prairie districts, where surface water will not drain off, filling the drill furrows, freezing and destroying the plants.

The result of this inquiry may be summarized, and the essential points presented, as follows:

1. Our correspondents very generally claim for the drill the fact that it tends to a clearing of the surface of obstructions and irregularities, the turning under of weeds and the refuse of the previous harvest, and a suitable preparation of the soil.

2. It enables the grower to place a fertilizer in close proximity to the seed, stimulating a vigorous early growth, till the roots reach out for nutriment to sustain the processes of later development, tillering and perfecting of the grain.

3. Less seed is required in drilling, amounting to a saving of half a bushel per acre, which would amount to nearly twenty million bushels were the entire wheat area drilled.

4. By this mode of seeding the grain is put in more evenly, its depth is regulated to reach a requisite degree of moisture promotive of prompt germination, and to secure ample growth and firm footing of the roots and better winter protection.

5. The plant starts more uniformly, makes a more regular stand and evener growth; and, when well established, tillers abundantly, if the soil is rich enough to give the requisite vigor. In a drought, if deeply planted, it comes up more quickly than surface planting that requires rain before germination, and stands better in after growth during a dry season.

6. Drilled land is better drained in winter; the disintegration of the drill furrow-sides furnishes food and protection for the plants; the de-

pression catches and holds the winter snows; while the ridge protects against the wintry winds.

7. In the South, and in other districts where pasturing wheat fields is practiced in fall or winter, it is found that drilled grain endures pasturing with less injury than broadcast, being more deeply and firmly rooted, and less affected by the trampling of cattle or horses.

8. Drilled wheat usually yields more per acre. There are few exceptions to this statement, occurring only where conditions are favorable to the growth of grain sown broadcast. The United States census for the year 1879 shows about 50 per cent. higher rate of production in the winter-wheat districts of the Ohio Valley, where the use of the drill is general, than in the spring-wheat region, where its use is limited. How much of this difference is due to prevalence of drilling may not be exactly determined.

RATES OF WAGES OF FARM LABORERS IN THE UNITED STATES.

The first systematic general investigation of the rate of wages paid for farm labor in the United States was undertaken in December, 1866, by the Division of Statistics of this Department. Some thirty years previously Mr. H. C. Carey had made a careful estimate, from the best information attainable, and placed the average wages of the whole country at $9 per month, with board. In 1866, from returns embracing about 1,500 counties, the average rate was found to be $15.50, with board, showing an apparent increase of about 72 per cent. in one generation.

At the same date the average monthly wages, when board was not provided, was $26 for the whole country, and for the States employing white labor almost exclusively, $28.

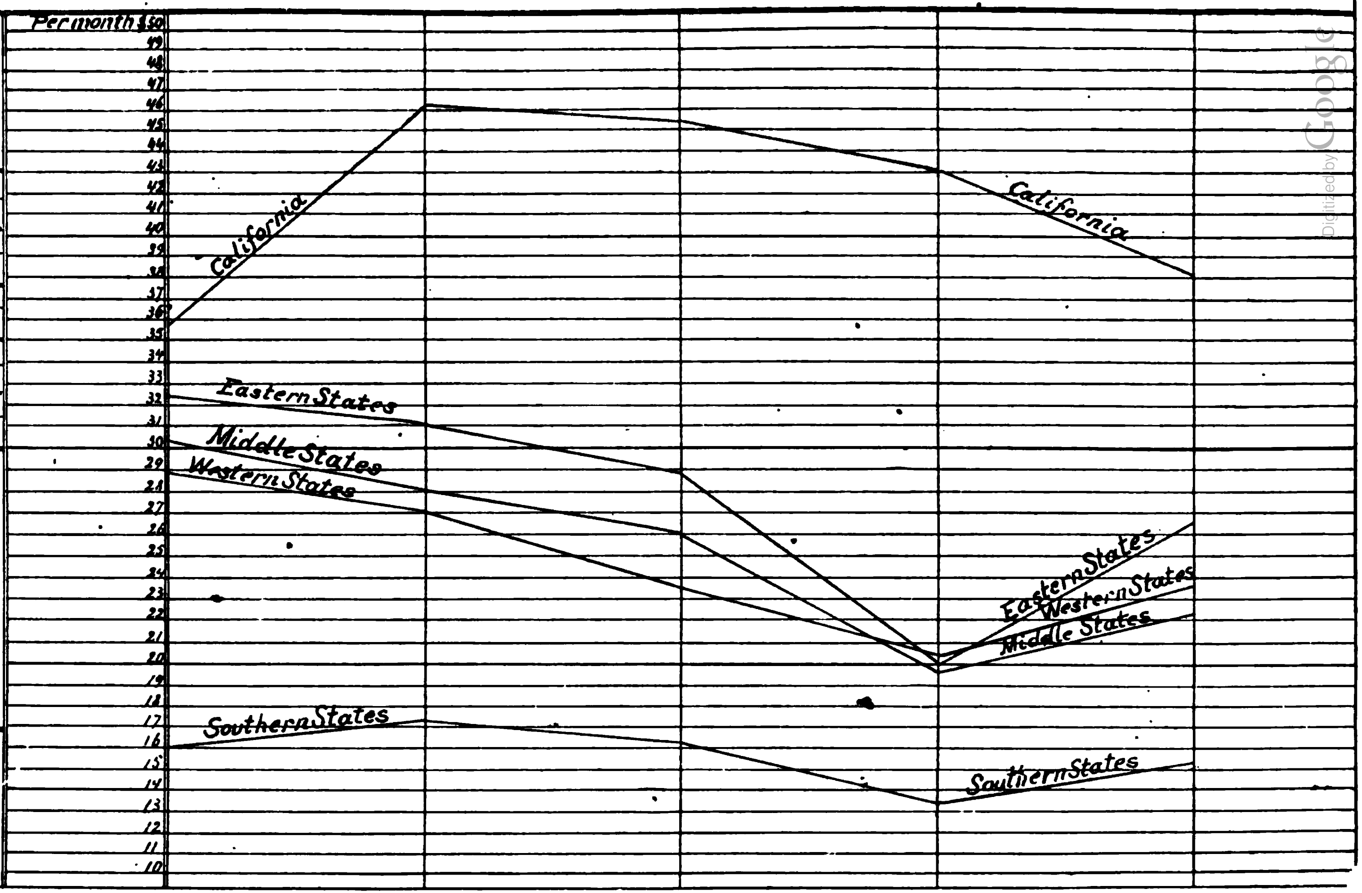
In the next three years there was a material decline in the value of farm products, to which labor yielded more slowly, the average rate in 1869 being $25.13 for labor without board. Prices had increased in the South, and had been somewhat better maintained in the Eastern than in the Western States, in consequence of the great activity of textile manufactures and iron production. The decline, though general, was nowhere very great in this period.

In 1875, another investigation showed a stronger tendency to a lower rate, somewhat more pronounced in the West and in New England than in the Middle States. The reduction in six years had been from $32.08 to $28.96 in the East, from $28.02 to $26.02 in the Middle States, and from $27.01 to $23.60 in the West.

The cumulative and extreme effect of the monetary revulsion which commenced late in 1873 was not reached for several years after. At the next investigation, in 1879, the time of deepest depression and distress of the laboring classes in manufacturing industry, when surplus laborers had been thrown into competition with farm labor, a general and heavy reduction was recorded. It was greatest now in manufacturing States, amounting to 30 per cent. in New England, 25 in the Middle States, and but 14 in the Western. The neighborhoods contiguous to great manufacturing centers suffered the largest decrease. The artisans of Massachusetts, for instance, thrown out of employment, returned to their former occupation in the neighboring States, and their competition with rural labor depressed the rate severely; thus the decline in Maine was from $25.40 to $18.25; in New Hampshire, $28.57

Diagram showing the average rate of wages per month for groups of States in 1866-1869-1875-1879 and 1882-

		1866		1869		1875		1879		1882	
California	$	35	75	46	38	44	50	41	00	38	25
Eastern States	$	33	30	32	08	28	96	20	21	26	61
Middle States	$	30	07	28	02	26	02	19	69	22	24
Western States	$	28	91	27	01	23	60	20	38	23	63
Southern States	$	16	00	17	21	16	22	13	31	15	30



to $19.75; in Vermont, $29.67 to $19. No other section showed a decline of 30 per cent. in four unfortunate years.

The present investigation shows the degree of recovery during the past three years of business activity and financial confidence. The following statement presents the average rate of wages (without board) in employment by the season or year:

	1882.	1879.	1875.	1869.	1866.
Eastern States	$26 61	$20 21	$28 96	$32 08	$33 30
Middle States	22 24	19 69	26 02	28 02	30 07
Southern States	15 30	13 31	16 22	17 21	16 00
Western States	23 63	20 38	23 60	27 01	28 91
California	38 25	41 00	44 50	46 38	35 75

These averages indicate a recovery of the status of 1875 in the West, a near approach to the rate of that year in the New England States, and a partial restoration in the Middle States. There is still a decline of 20 per cent. or more from the inflated rates of the flush times immediately following the civil war.

There is one point, relative to wages in the South, of striking significance, viz, with the same tendency to recede from 1869 to 1879 and to advance from the latter date to the present time, the movement is very moderate, the decline being only 14 per cent., while in other sections it was between 30 and 40. The reason is obvious to those who know the history of the labor movement. Southern labor is about half negro labor, and it has been gradually and surely improving in quality, commanding appreciation, so that it brings to-day very nearly the same price when cotton is 12 cents per pound as it commanded when cotton was worth 30 cents per pound. In comparison with wages in other sections Southern rates are low, because less intelligent and efficient, and applied mainly to a single routine of cropping.

The changes are shown in these approximate percentages of decrease and increase of sections:

	Eastern.	Middle.	Western.	Southern.
Decrease from 1866 to 1879	39	35	30	14
Increase from 1879 to 1882	24	12	14	13

California is somewhat peculiar in prices, as in crop distribution and production. There was an extraordinay advance in wages from 1866 to 1869. Since that date the decline has been gradual and comparatively uniform, and has continued through the last three years, while the movement has been upward everywhere except on the Pacific coast. Yet the rate is still very high in comparison with that of any other section. The exemption of that region from the effects of the monetary revulsion is illustrated by a diagram showing the movement of wages.

The following table presents the average rates of wages of farm labor, with and without board, in 1866, 1869, 1875, 1879, and 1882:

Statement showing the average monthly rate of wages, by the year, for the years respectively named.

States.	1882.		1879.		1875.		1869.		1866.	
	Without board.	With board.	Without board.	With board.	Without board.	With board.	Without board.	With board.	Without board.	With board.
Maine	$24 75	$16 15	$18 25	$11 08	$25 40	$15 94	$28 25	$16 50	$27 00	$17 44
New Hampshire	25 25	16 72	19 75	12 30	28 57	18 25	32 66	22 16	32 74	22 48
Vermont	23 37	16 00	19 00	11 50	29 67	19 37	32 40	21 40	32 84	21 09
Massachusetts	30 06	18 25	25 00	15 33	31 87	20 25	35 95	22 16	38 94	22 36
Rhode Island	27 75	17 00	23 00	13 26	30 00	19 60	32 25	20 00	34 40	20 50
Connecticut	27 90	17 87	23 29	14 23	28 25	18 50	33 00	20 75	34 25	21 54
New York	23 63	15 36	20 61	13 19	27 14	17 80	29 28	18 64	29 57	19 32
New Jersey	24 25	14 20	20 22	11 53	30 71	16 78	32 11	19 02	32 27	18 98
Pennsylvania	22 88	14 21	19 92	11 46	25 89	16 10	28 68	18 05	29 91	18 84
Delaware	18 20	12 50	17 00	9 50	20 33	11 67	23 00	13 00	24 93	13 25
Maryland	16 34	9 89	14 00	8 95	20 02	11 42	21 55	12 00	20 36	12 76
Virginia	13 96	9 17	11 00	7 66	14 84	9 21	15 28	9 65	14 82	9 38
North Carolina	12 86	8 80	11 19	7 66	13 46	8 82	12 76	7 91	13 46	8 15
South Carolina	12 10	8 10	10 25	6 66	12 84	8 19	11 54	7 34	12 00	7 66
Georgia	12 86	8 70	10 73	7 38	14 40	8 79	14 70	9 70	15 51	9 67
Florida	16 64	10 20	13 80	8 73	15 50	10 75	16 10	10 91	18 00	12 13
Alabama	13 15	9 09	12 30	8 30	13 60	9 40	15 19	10 52	13 40	9 80
Mississippi	15 10	10 09	13 81	9 28	16 40	11 26	17 11	11 21	16 72	11 58
Louisiana	18 20	12 69	16 40	11 27	18 40	12 20	21 37	12 62	20 50	12 42
Texas	20 20	14 03	18 27	11 49	19 50	13 37	18 88	13 21	19 00	12 73
Arkansas	18 50	12 25	17 12	11 31	20 50	13 00	25 25	16 60	24 21	15 80
Tennessee	13 75	9 49	12 73	8 60	15 20	10 00	16 81	11 00	19 60	12 58
West Virginia	19 16	12 46	16 98	10 94	20 75	13 10	21 89	13 87	25 35	16 47
Kentucky	18 20	11 75	15 17	10 00	18 12	12 00	18 84	12 57	20 23	13 65
Ohio	24 55	16 30	20 72	13 34	24 05	16 33	26 35	16 74	28 46	18 96
Michigan	25 76	17 27	22 88	14 64	28 22	18 46	31 01	20 03	31 26	20 46
Indiana	23 14	15 65	20 20	12 76	24 20	16 14	25 42	17 03	27 71	18 72
Illinois	23 91	17 14	20 61	13 01	25 20	16 87	27 32	17 69	28 54	18 72
Wisconsin	26 21	17 90	21 07	13 81	25 50	16 45	30 08	18 47	30 81	19 87
Minnesota	26 36	17 75	24 56	15 62	26 16	16 36	28 61	17 94	31 65	21 10
Iowa	26 21	17 95	22 09	13 90	24 35	16 11	28 39	17 87	28 34	18 87
Missouri	22 89	13 96	17 59	11 84	19 40	13 15	24 47	16 38	26 75	18 08
Kansas	23 85	15 87	20 67	13 28	28 20	14 65	28 96	18 88	31 08	19 81
Nebraska	24 45	16 20	23 04	14 86	24 00	14 75	33 25	19 18	38 27	24 64
California	38 25	23 45	41 00	26 27	44 50	28 60	46 38	28 69	45 71	30 25
Oregon	33 50	24 75	35 45	23 86	38 25	25 67	....	....	35 75	22 53
Colorado	36 50	27 08	35 00	20 00	38 50	21 14	....	....	67 50	42 12
Utah	....	....	28 87	20 50	35 50	25 33	....	....	44 71	28 33
New Mexico	....	....	22 10	13 80	22 75	14 25	....	....	25 00	16 50
Dakota	....	....	28 56	16 57	32 50	20 50	....	....	30 20	20 00

A fair illustration of average wages and average conditions of farm labor in the United States is furnished by the central belt of States on the parallel of 40°, and the changes of the past fifteen years are also clearly shown in the figures which they present. From Ohio to Iowa rates were nearly equal in 1866, in Pennsylvania they were slightly higher, and in Nebraska an entirely exceptional condition existed, immigrants pouring in to claim and possess the free virgin soil, and declining to work for wages at any rates, however high. In three years conditions changed materially, and in nine years, when production became abundant, the rate of wages of Nebraska ranged in line with the more eastern States of the fortieth parallel, as we see; in 1875 the whole range of difference in monthly rate from the Alleghanies to the Rocky Mountains was only $1.20.

In 1879, the date of lowest prices, we find a sharp decline has occurred during the four years of business depression, which is wonderfully uniform in the older agricultural States—Ohio, Indiana, and Illinois—but much more severe in the manufacturing State of Pennsylvania, and comparatively small in the newer States beyond the Mississippi, into which a stream of immigration was pouring, requiring food and every kind of supplies necessary for farm equipment.

At this date the tide turned with resumption and specie payments, and the present investigation shows an advance all along the line of about three dollars per month in all the States east of the Mississippi, bringing the average nearly up to that of 1875, except in Pennsylvania. Beyond the Mississippi the average is higher than in 1875. The following statement shows for these several dates, from 1866 to 1882, the—

Average monthly wages of laborers employed by the year.

States.	1882.	1879.	1875.	1869.	1866.
Pennsylvania	$22 88	$19 92	$25 89	$28 68	$29 91
Ohio	23 87	20 72	24 05	26 35	28 46
Indiana	23 14	20 20	24 20	25 42	27 71
Illinois	23 91	20 61	25 20	27 32	28 54
Iowa	26 21	22 09	24 85	28 39	28 34
Nebraska	24 45	23 04	24 00	33 25	38 37

The influence of manufacturers upon agriculture is seen in the wages of farm labor as well as in the prices of farm production. The rate is higher in Massachusetts than in any other State east of the Rocky Mountains. It is seen in the west as well, affecting the averages of States lying side by side. Ohio has become a manufacturing State of considerable importance. It is dotted over with cities of 20,000 to 60,000 people, largely interested in manufacturing industry. Kentucky, on the other bank of the Ohio, is occupied mainly with the pursuits of agriculture. This fact, together with the larger proportion of negro labor, reduces the rate of wages. The comparison is as follows:

States.	1882.	1879.	1875.	1869.	1866.
Ohio	$24 55	$20 72	$24 05	$26 35	$28 46
Kentucky	18 20	15 17	18 12	18 84	20 23

There is a marked difference in the several districts of Ohio. The northern belt includes the manufacturing centers—Cleveland, Toledo, Canton, Wooster, Mansfield, and other towns—and is a seat of profitable dairy and other rural interests.

The effect is seen in a high rate of wages. The limestone district lying between the Scioto and Indiana line, and including the Miami valleys, has also several towns prominent in manufacturing interprise, like Cincinnati, Columbus, Dayton, and Springfield, and the wages of farm labor are also high. The country east of the Scioto has iron and coal industries, with comparatively little variety in general manufactures, and a more exclusive reliance upon agriculture.

The comparison is thus made:

	Per month.
Northern district	$25 96
Western district	24 75
Eastern district	22 65

In population, variety of industry, and general industrial advancement, the northern district of Illinois surpasses the southern. Naturally the wages of agricultural labor reflect this difference. Dividing the State on the line of counties reaching below the forty-first parallel, and again on the line of the twenty-ninth parallel, the average wages are, respectively, from north to south, as follows:

	Per month.
Northern district	$27 52
Central district	24 05
Southern district	19 87

Proximity to large cities increases the rate. New Jersey has the advantage of extensive manufactures within her limits, and the added advantage of cities immediately on her borders holding a population of three millions of people engaged in manufactures and commerce. The effect is as follows:

States.	1882.	1879.	1875.	1869.	1866.
New York	$23 63	$20 61	$27 14	$29 28	$29 57
New Jersey	24 25	20 22	30 78	32 11	32 27
Pennsylvania	22 88	19 92	25 89	28 68	29 91

Only in the time of manufacturing depression, as in 1879, does New Jersey report wages as low as those of New York, whose rural territory extends to the great lakes.

Whenever other industries flourish, and the number of persons employed in agriculture are fewer than those engaged in other occupations, it is found that the wages of farm labor are higher than in districts more exclusively agricultural; and statistics show, further, that the prices of farm products are also higher, and the gross and net earnings of the farm proprietor are greater. Wherever from manufactures, mining, or commerce the non-agricultural population is relatively in smaller proportion to the whole people, the law of supply and demand inevitably secures a higher reward to rural labor.

TRANSIENT WAGES IN HARVEST.

The higher wages in harvest will uniformly be found in the wheat-growing States of the Northwest and California, because of the extraordinary prominence of a single crop, which is an absorbing specialty. In the winter-wheat region, Michigan, for a similar reason, offers high wages for labor and harvest. The harvest in the South is a longer season, not so exacting in demands for immediate and speedy conclusion, and wages are therefore lower, relatively, than transient service in the West.

The range of rates in the present investigation runs from $1.05 in Alabama to $2.65 in Dakota.

Table showing the rate of wages of agricultural labor per day in harvest.

States.	1882.		1879.		1875.		1869.		1866.	
	In harvest (without board).	In harvest (with board).	In harvest (without board).	In harvest (with board).	In harvest (without board).	In harvest (with board).	In harvest (without board).	In harvest (with board).	In harvest (without board).	In harvest (with board).
Maine	$1 52	$1 22	$1 42	$1 00	$1 90	$1 40	$2 17	$1 65	$2 02	$1 56
New Hampshire	1 71	1 35	1 35	96	2 06	1 64	2 87	1 95	1 96	1 52
Vermont	1 75	1 35	1 29	97	2 28	1 85	2 46	2 00	2 82	1 85
Massachusetts	1 75	1 35	1 50	1 00	1 90	1 50	2 87	1 95	2 41	1 92
Rhode Island	1 60	1 30	1 30	95	2 00	1 50	2 87	1 75	2 28	1 71
Connecticut	1 65	1 33	1 60	1 25	2 06	1 58	2 40	1 90	2 48	1 96
New York	1 89	1 47	1 58	1 18	2 25	1 75	2 58	1 90	2 41	1 92
New Jersey	2 09	1 74	1 55	1 30	2 56	2 08	2 68	2 09	2 68	2 38
Pennsylvania	1 73	1 30	1 33	99	2 01	1 51	2 28	1 73	2 32	1 80
Delaware	1 60	1 25	1 37	1 00	1 88	1 41	1 87	1 50	2 09	1 62
Maryland	1 52	1 15	1 48	1 12	1 81	1 34	2 16	1 67	2 00	1 68
Virginia	1 27	99	1 16	96	1 46	1 21	1 48	1 13	1 46	1 21
North Carolina	1 20	85	90	76	1 17	1 00	1 37	1 04	1 53	1 17
South Carolina	1 08	78	89	68	1 17	1 01	1 15	90	1 25	68
Georgia	1 10	80	98	61	1 29	99	1 34	90	1 48	1 06
Florida	1 12	80	1 02	73	1 00	73	1 26	87	1 12	88
Alabama	1 05	80	96	77	1 40	1 15	1 24	95	1 27	1 04
Mississippi	1 23	95	1 00	85	1 40	1 00	1 56	1 27	1 65	1 14
Louisiana	1 10	85	1 08	77	1 30	1 05	1 54	1 13	1 66	1 20
Texas	1 39	1 08	1 30	94	1 63	1 30	1 68	1 26	1 65	1 33
Arkansas	1 34	1 02	1 38	1 08	1 50	1 25	1 67	1 40	2 07	1 52
Tennessee	1 30	1 00	1 28	98	1 62	1 30	2 10	1 50	2 01	1 54
West Virginia	1 30	1 00	1 26	95	1 55	1 30	1 78	1 29	1 78	1 51
Kentucky	1 54	1 18	1 49	1 15	1 79	1 46	1 88	1 38	2 10	1 70
Ohio	1 79	1 41	1 51	1 17	2 65	1 60	2 15	1 72	2 20	1 73
Michigan	2 13	1 76	2 02	1 55	2 50	2 00	2 76	2 26	2 62	2 14
Indiana	1 89	1 58	1 68	1 28	2 20	1 75	2 16	1 77	2 28	1 76
Illinois	1 91	1 54	1 52	1 18	2 20	1 88	2 34	1 94	2 41	1 91
Wisconsin	2 50	2 10	2 11	1 70	2 40	1 92	2 45	1 96	2 68	2 15
Minnesota	2 61	2 16	2 63	2 25	2 82	2 30	2 90	2 36	2 68	2 27
Iowa	2 25	1 81	1 66	1 57	2 57	2 10	2 86	2 24	2 38	1 88
Missouri	1 59	1 23	1 47	1 16	1 75	1 43	2 30	1 84	2 15	1 73
Kansas	1 70	1 35	1 70	1 32	1 86	1 40	2 08	1 63	2 31	1 82
Nebraska	1 95	1 57	2 17	1 66	2 40	1 96	2 41	2 00	2 65	2 15
California	2 30	1 86	2 27	1 76	2 50	2 00	2 83	2 04	2 56	2 06
Oregon	1 92	1 50	2 02	1 54	2 11	1 72	....	....	2 40	1 80
Colorado	2 21	1 80	2 08	1 55	2 33	1 50	....	....	4 17	2 87
Utah	2 00	1 56	1 82	1 43	2 20	1 75	....	....	3 42	2 49
New Mexico	1 65	1 40	1 00	67	1 85	90	....	....	1 50	1 12
Washington	....	....	2 15	1 61	2 40	2 00	....	....	3 00	2 25
Dakota	2 65	2 19	....	....	2 87	1 80	....	....	2 50	2 00

Table showing the average rate of wages per day, in transient service, other than harvesting.

States.	1882.		1879.		1875.		1869.		1866.	
	Without board.	With board.	Without board.	With board.	Without board.	With board.	Without board.	With board.	Without board.	With board.
Maine	$1 18	$0 91	$0 97	$0 72	$1 46	$1 05	$1 48	$1 05	$1 49	$1 13
New Hampshire	1 30	97	98	74	1 50	1 12	1 79	1 41	1 67	1 36
Vermont	1 20	90	91	64	1 51	1 11	1 76	1 28	1 76	1 32
Massachusetts	1 45	1 08	1 05	75	1 44	1 12	1 92	1 37	1 83	1 38
Rhode Island	1 28	1 00	1 00	50	1 62	1 18	1 73	1 18	1 83	1 33
Connecticut	1 30	98	1 50	88	1 50	1 16	1 87	1 37	1 75	1 29
New York	1 29	93	92	68	1 48	1 06	1 64	1 19	1 75	1 23
New Jersey	1 21	86	99	68	1 45	1 00	1 63	1 15	1 68	1 20
Pennsylvania	1 20	85	96	63	1 87	95	1 43	1 04	1 59	1 10
Delaware	1 10	80	75	50	1 04	70	1 30	95	1 31	94
Maryland	83	55	75	48	1 06	71	1 20	77	1 31	96
Virginia	70	48	63	44	78	51	80	55	82	57
North Carolina	68	46	58	41	72	51	74	49	72	50
South Carolina	65	45	53	41	71	55	70	50	69	45
Georgia	70	49	58	44	83	60	83	60	99	76
Florida	75	55	76	53	93	70	96	72	1 00	74
Alabama	72	51	69	50	75	53	86	61	78	55
Mississippi	75	55	78	55	1 07	80	1 10	90	1 34	89
Louisiana	80	60	85	62	1 00	74	1 04	83	1 06	70
Texas	93	70	92	66	1 14	84	1 16	84	1 31	98
Arkansas	88	62	86	60	1 10	80	1 36	1 02	1 34	88
Tennessee	72	50	69	50	95	60	1 05	68	1 15	83
West Virginia	82	59	80	55	1 05	75	1 14	79	1 31	92
Kentucky	87	60	77	53	1 03	72	1 10	77	1 21	86
Ohio	1 19	89	1 00	83	1 35	1 00	1 44	1 05	1 54	1 13
Michigan	1 30	96	1 16	82	1 55	1 10	1 66	1 17	1 78	1 30
Indiana	1 08	78	90	69	1 30	95	1 36	1 01	1 45	1 06
Illinois	1 19	90	1 01	73	1 37	1 01	1 50	1 13	1 62	1 21
Wisconsin	1 33	99	1 12	79	1 42	1 00	1 56	1 15	1 78	1 28
Minnesota	1 37	1 02	1 27	94	1 50	1 07	1 64	1 18	1 75	1 35
Iowa	1 34	99	1 12	80	1 38	1 01	1 52	1 13	1 63	1 19
Missouri	1 00	70	67	59	1 07	78	1 44	1 02	1 44	1 07
Kansas	1 12	80	1 05	72	1 30	90	1 56	1 12	1 65	1 19
Nebraska	1 21	91	1 29	90	1 43	1 00	1 62	1 26	1 93	1 45
California	1 71	1 29	1 65	1 23	1 84	1 30	2 13	1 50	2 26	1 72
Oregon	1 33	1 00	1 44	1 08	1 47	1 15	....	....	1 75	1 40
Nevada	....	....	....	1 25	....	....	....	....	3 06	2 50
Colorado	1 63	1 14	1 83	1 19	1 75	1 16	....	....	3 29	1 93
Utah	1 57	1 10	1 46	1 12	1 80	1 40	....	....	2 27	1 63
New Mexico	1 28	1 00	81	56	85	50	....	....	1 00	90
Dakota	1 50	1 11	1 34	92	1 62	1 08	....	....	2 00	1 50
Wyoming	....	....	....	....	3 08	2 36	....	....	....	....

POPULATION.

The following are results of the census of population of the United States in June, 1880:

Persons	50,155,783
Areas in square miles	2,900,170
Families	9,945,916
Dwellings	8,955,812
Persons to a square mile	17.29
Families to a square mile	3.43
Dwellings to a square mile	3.02
Acres to a person	37.01
Acres to a family	186.62
Persons to a dwelling	5.60
Persons to a family	5.04

The classification of total numbers of the population by *age* and *sex* is as follows:

Ages.	All classes.		
	Total.	Males.	Females.
All ages	50,155,783	25,518,820	24,636,963
Under 1 year	1,447,983	734,024	713,959
1 year	1,256,956	638,032	618,924
2 years	1,427,086	726,038	701,048
3 years	1,381,274	697,209	684,065
4 years	1,401,217	712,406	688,811
Under 5 years	6,914,516	3,507,709	3,406,807
5 to 9 years	6,479,660	3,275,131	3,204,529
10 to 14 years	5,715,186	2,907,481	2,807,705
15 to 19 years	5,011,415	2,476,088	2,535,327
20 to 24 years	5,087,772	2,554,684	2,533,088
25 to 29 years	4,080,621	2,109,741	1,970,880
30 to 34 years	3,368,943	1,744,308	1,624,635
35 to 39 years	3,000,419	1,527,159	1,473,260
40 to 44 years	2,468,811	1,243,773	1,225,038
45 to 49 years	2,089,445	1,078,695	1,010,750
50 to 54 years	1,839,883	966,702	873,181
55 to 59 years	1,271,434	674,927	596,507
60 to 64 years	1,104,219	584,858	519,361
65 to 69 years	725,876	379,498	346,378
70 to 74 years	495,442	250,001	245,441
75 to 79 years	281,065	138,601	142,464
80 to 84 years	146,362	67,941	78,421
85 to 89 years	49,835	21,908	27,927
90 to 94 years	16,100	6,351	9,749
95 to 99 years	4,703	1,855	2,908
100 years and over	4,016	1,409	2,607

FARMS OF THE UNITED STATES.

The increase in number of farms, in decennial periods, as shown by the national census, is as follows:

1850	1,449,073
1860	2,044,077
1870	2,659,985
1880	4,008,907

It is the distinctive peculiarity of American farm occupancy that the tillers of the soil are owners of the land. Foreigners come here not to become tenants, but proprietors. They move directly onward toward the free government lands, which furnish a vital inducement to immigration. They go West rather than South; first, because they can obtain the best lands in fee simple, and not as renters; and a second consideration is the fact that prairie lands can be selected which can be opened and made productive the first year. Therefore we find that 2,984,306, or about three-fourths of all in number, and a far greater proportion of the total value, are occupied by the owner. Then there are persons temporary occupants of holdings for various reasons in the North, and in the South a large number of freedmen who are averse to working for wages, and unable to own and stock a farm, who are compelled to work the land for others. Preferring semi-proprietorship or a sort of partnership in the produce of the farm, there are 702,244 who occupy land on shares in various proportions, according to the fertility of the soil and the conditions of the partnership, as to furnishing and feeding of farm animals, the use of implements, &c. The following figures will show how much smaller are these farms, which are usually fragments of original farms of greater area. The number rented at a fixed rental in money is very small—only 322,357. The following statement gives the classification by size and also by tenure:

Number of acres.	Whole number.	Occupied by owner.	Rented for money.	Rented on shares.
Under 3 acres	4, 352	2, 601	875	876
3 acres and under 10	134, 889	85, 456	22, 904	26, 529
10 acres and under 20	254, 749	122, 411	41, 522	90, 816
20 acres and under 50	781, 474	460, 486	97, 399	223, 589
50 acres and under 100	1, 032, 910	804, 522	69, 663	158, 725
100 acres and under 500	1, 695, 983	1, 416, 618	84, 645	194, 720
500 acres and under 1,000	75, 972	66, 447	3, 956	5, 569
1,000 acres and over	28, 578	25, 765	1, 393	1, 420
Total	4, 008, 907	2, 984, 306	322, 357	702, 244

Classification of farms in the United States, by size.

States.	Number.	Under 3 acres.	3 and under 10.	10 and under 20.	20 and under 50.	50 and under 100.	100 and under 500.	500 and under 1,000.	1,000 and over.
Alabama	135, 864	277	3, 597	13, 055	41, 721	26, 447	44, 254	4, 645	1, 366
Arizona	767	......	......	......	......	......	......	......	......
Arkansas	94, 433	97	2, 070	10, 780	19, 282	21, 787	37, 976	1, 793	648
California	35, 934	143	1, 064	1, 430	3, 475	3, 969	20, 214	3, 108	2, 531
Colorado	4, 506	......	......	......	......	......	......	......	......
Connecticut	30, 598	34	2, 261	3, 247	7, 288	8, 107	9, 511	133	17
Dakota	17, 435	6	36	63	210	547	16, 253	246	74
Delaware	8, 749	4	311	484	1, 205	2, 089	4, 631	66	9
District of Columbia	435	......	......	......	......	......	......	......	......
Florida	23, 438	69	1, 301	2, 456	7, 640	4, 381	6, 562	652	377
Georgia	138, 626	101	3, 110	8, 694	36, 524	26, 054	53, 635	7, 017	3, 491
Idaho	1, 885	......	......	......	......	......	......	......	......
Illinois	255, 741	138	4, 170	8, 299	46, 594	76, 090	116, 562	3, 240	649
Indiana	194, 013	200	4, 663	8, 019	43, 403	64, 030	72, 103	1, 320	275
Iowa	185, 351	122	2, 063	8, 334	23, 488	58, 519	95, 163	2, 298	364
Kansas	138, 561	62	997	1, 658	9, 539	31, 078	93, 823	1, 169	235
Kentucky	166, 453	313	6, 759	13, 728	30, 673	40, 594	69, 472	3, 802	1, 112
Louisiana	48, 292	100	1, 848	6, 708	12, 626	8, 501	15, 631	2, 159	1, 319
Maine	64, 309	95	2, 039	3, 132	11, 489	22, 025	25, 035	378	116
Maryland	40, 517	151	2, 760	3, 293	5, 948	7, 768	19, 792	728	77
Massachusetts	38, 406	......	......	......	......	......	......	......	......
Michigan	154, 008	68	2, 737	4, 514	45, 029	55, 777	45, 391	408	84
Minnesota	92, 386	36	604	952	8, 008	25, 530	56, 375	741	145
Mississippi	101, 772	84	3, 396	11, 936	36, 836	19, 318	35, 493	3, 906	1, 833
Missouri	215, 775	122	3, 460	8, 647	43, 736	58, 030	97, 350	3, 536	685
Montana	1, 519	......	......	......	......	......	......	......	......
Nebraska	63, 387	46	355	708	3, 301	16, 652	41, 542	666	118
Nevada	1, 404	......	......	......	......	......	......	......	......
New Hampshire	32, 181	111	1, 721	2, 036	5, 662	8, 716	13, 446	385	104
New Jersey	34, 307	64	2, 342	3, 721	7, 682	9, 617	10, 674	147	60
New Mexico	5, 053	14	1, 633	1, 055	849	484	919	56	43
New York	241, 058	279	14, 543	17, 239	40, 386	70, 661	96, 273	1, 815	261
North Carolina	157, 609	277	7, 273	13, 314	34, 148	34, 007	61, 806	5, 063	1, 721
Ohio	247, 189	212	10, 951	14, 167	49, 365	78, 298	92, 645	1, 309	252
Oregon	16, 217	13	172	207	679	1, 723	11, 791	1, 280	332
Pennsylvania	213, 542	250	14, 017	16, 974	38, 331	63, 927	78, 877	922	244
Rhode Island	6, 216	12	418	607	1, 391	1, 706	2, 029	48	5
South Carolina	93, 864	118	7, 035	12, 519	27, 517	18, 612	27, 785	3, 693	1, 635
Tennessee	165, 650	......	......	......	......	......	......	......	......
Texas	174, 184	......	......	......	......	......	......	......	......
Utah	9, 452	18	416	1, 313	3, 688	2, 056	1, 916	46	9
Vermont	35, 522	5	1, 488	1, 767	3, 973	7, 822	19, 785	585	97
Virginia	118, 517	101	7, 012	9, 668	19, 822	23, 194	53, 101	5, 681	1, 563
Washington	6, 529	13	74	71	207	611	5, 239	252	62
West Virginia	62, 674	64	2, 797	3, 463	8, 488	14, 461	30, 301	2, 255	845
Wisconsin	134, 322	98	2, 516	3, 200	22, 718	44, 719	60, 296	696	100
Wyoming	457	......	......	......	......	......	......	......	......
The United States	4, 008, 907	......	......	......	......	......	......	......	......

SUGAR CANE.

(1879 Census.)

States.	Acres.	Sugar.	Molasses.
		Hhds.	*Gallons.*
Alabama	6,627	94	795,199
Florida	7,938	1,273	1,029,868
Georgia	15,053	601	1,565,784
Louisiana	181,592	171,706	11,696,248
Mississippi	4,555	18	536,625
South Carolina	1,787	229	138,944
Texas	10,224	4,951	810,605
Total	227,776	178,872	16,573,273

RICE.

(1879 Census.)

States.	Acres.	Pounds.	Average yield per acre.
			Pounds.
Alabama	1,579	810,889	514
Florida	2,551	1,294,677	508
Georgia	34,973	25,369,687	725
Louisiana	42,000	23,188,311	552
Mississippi	3,501	1,718,951	491
North Carolina	10,846	5,609,191	517
South Carolina	78,388	52,077,515	664
Texas	335	62,152	186
Total	174,173	110,131,373	632

INCOMPLETE RETURNS OF STATE ASSESSORS.

Few of the States, through assessors or other officers, make any pretense of obtaining annual statistics of farm crops or even farm animals. Some of the more enterprising, mostly in the West (probably because of the greater local prominence of agricultural production), have for several years collected and published such statistics. The effort is worthy of high commendation, and important results have followed it. It has done much in educating the people in statistical methods and the profitable uses of farm statistics. It is unfortunate that assessors, who precede the tax gatherer and decide the extent of his levy upon the results of rural industry, should generally be the agents for this purpose. The mind of the less intelligent cannot avoid some degree of suspicion that taxation will be in proportion to their crops and live stock; and their statements, if estimates, will incline to conservatism. This is a natural theory, and it is found to be a proven fact. As education in general and statistical intelligence in particular shall be advanced this difficulty will diminish. It is decreasing, and in some States the approximation to fullness of returns is becoming close.

Comparing State returns with the United States census, it is found that they are always lower in aggregates than those of the national census, and in States where the work is of recent origin or carelessly executed the disparity is still greater. Generally the labor is unpaid in State enumerations, and that fact is often openly made the excuse for failure to report with full completeness. The United States census was formerly taken under the direction of United States marshals who were selected for other duties, and the work suffered inevitably from this cause, and was, in a measure, incomplete, though still fuller than

State returns. The recent national census has been taken under better auspices, and is nearer complete in returns than any former Federal or State enumeration in this country.

The following table presents a comparison of results which will illustrate the idea here presented. It will be seen that in Ohio the average yield of corn is 34.1 bushel per acre in the Federal and 34.3 in the State census. Wheat averages 18 and 17.7 bushels, respectively. This is very close; but the acres are more in the former case. In Michigan it is 19.5 to 19.3 for wheat; 33.9 to 34.2 for oats. In Illinois the corn average is identical in both enumerations; barley, 22.2 to 22.7. So in Minnesota; there is little difference in yield per acre; and the acres and bushels are proportionally larger in the national census. This is the invariable rule, showing that certain farms, neglected by the assessors, have failed to appear in the aggregate of production. The loss is in some cases 8 per cent., in others 10 or 12, and more in minor crops, like potatoes, and greater in some States than in others.

In the case of corn, in Michigan, there is another cause of difference, the vicious habit of reporting bushels of ears instead of bushels of shelled corn. In this case the census may be somewhat at fault in the yield per acre, for, though enumerators were directed to return corn as shelled, there were many who returned ears as shelled corn. It caused a troublesome investigation, and the throwing out of 4,000,000 bushels of *cobs*. But there was doubtless more that could not be proven to be ears, which remained to swell unduly the aggregate. For the same cause, the State returns must be equally inaccurate. It is to be hoped that Michigan farmers and State officials will learn to report the yield in the measure recognized by law and commercial usage.

There is one exception to the universality of this rule of lower aggregates of State returns. Kansas is higher in every instance, and in wheat and oats so much higher as to invalidate seriously the correctness either of the Federal or State figures. It would be invidious to theorize upon the cause of such discrepancy.

INCOMPLETE RETURNS OF STATE ASSESSORS.

KENTUCKY.

Crops.	United States census.			State assessors.		
	Acres.	Bushels.	Yield per acre.	Acres.	Bushels.	Yield per acre.
Corn	3, 021, 176	72, 852, 263	24. 1	....	51, 906, 204	....
Wheat	1, 160, 108	11, 356, 113	9. 8	....	7, 018, 427	....
Barley	20, 089	486, 326	24. 2	....	398, 795	....

OHIO.

Crops.	U.S. Acres.	U.S. Bushels.	U.S. Yield per acre.	State Acres.	State Bushels.	State Yield per acre.
Corn	3, 281, 923	111, 874, 124	34. 1	2, 824, 480	96, 908, 800	34. 3
Wheat	2, 556, 134	46, 014, 869	18	2, 318, 260	41, 052, 120	17. 7
Oats	910, 388	28, 664, 505	31. 5	840, 001	25, 524, 699	30. 4
Rye	29, 499	389, 221	13. 2	26, 506	318, 995	12
Barley	57, 482	1, 707, 129	29. 7	51, 688	1, 475, 637	28. 5
Buckwheat	22, 130	280, 229	12. 7	17, 925	217, 127	12. 1

MICHIGAN.

Crops.	U.S. Acres.	U.S. Bushels.	U.S. Yield per acre.	State Acres.	State Bushels.	State Yield per acre.
Corn	919, 792	32, 461, 452	35. 3	742, 859	21, 382, 061	28. 8
Wheat	1, 822, 749	35, 532, 543	19. 5	1, 606, 638	30, 983, 340	19. 3
Oats	536, 187	18, 190, 793	33. 9	440, 723	15, 069, 855	34. 2
Barley	54, 506	1, 204, 316	22. 1	44, 006	991, 659	22. 5

Incomplete returns of State assessors—Continued.

ILLINOIS.

Crops.	United States census.			State assessors.		
	Acres.	Bushels.	Yield per acre.	Acres.	Bushels.	Yield per acre.
Corn	9,019,381	325,792,481	36.1	7,592,152	274,161,028	36.1
Wheat	3,218,542	51,110,502	15.9	2,702,380	46,388,774	17.2
Oats	1,959,889	63,189,200	32.2	1,703,848	61,665,473	36.2
Rye	192,138	3,121,785	16.2	166,915	2,648,893	15.9
Barley	55,267	1,229,523	22.2	43,227	980,250	22.7
Buckwheat	16,457	178,859	10.9	10,786	112,180	10.4

MINNESOTA.

Crops.	Acres.	Bushels.	Yield per acre.	Acres.	Bushels.	Yield per acre.
Corn	438,737	14,831,741	33.8	379,766	12,939,901	33.95
Wheat	3,044,670	34,601,030	11.4	2,762,521	31,218,634	11.30
Oats	617,469	23,382,158	37.8	567,371	20,667,983	36.43
Rye	13,614	215,245	15.8	11,534	172,887	14.98
Barley	116,020	2,973,965	25.6	96,951	2,423,982	24.87
Buckwheat	3,677	41,756	11.4	3,380	33,168	9.80

KANSAS.

Crops.	Acres.	Bushels.	Yield per acre.	Acres.	Bushels.	Yield per acre.
Corn	3,417,817	105,729,325	30.9	2,995,070	108,704,927	36.3
Wheat	1,861,402	17,324,141	9.3	1,932,798	20,550,936	10.6
Oats	435,859	8,180,385	18.8	578,982	13,326,637	23.2
Rye	34,621	413,181	11.9	43,675	660,409	15.1
Barley	23,993	300,273	12.5	45,851	720,092	15.7
Buckwheat	2,458	24,421	9.9	2,817	41,306	14.7

PORK PACKING.

As maize is the national crop, found everywhere except upon the highest elevations, so the hog is the principal meat-producing animal in America, and Americans the most voracious pork-eaters in the world. It is the best evidence of the healthfulness of our swine that we are obliged to go to Europe for testimony to its discredit.

Number of hogs packed in the West for the twelve months ending March 1 for eleven years.

Years.	Summer.	Winter.	Total.	Net weight of hogs.
	Number.	*Number.*	*Number.*	*Pounds.*
1871–'72	250,000	4,831,558	5,081,558	1,146,033,885
1872–'73	505,500	5,410,314	5,915,814	1,353,564,288
1873–'74	1,062,916	5,466,200	6,529,116	1,369,640,599
1874–'75	1,200,444	5,566,226	6,766,670	1,364,512,267
1875–'76	1,262,343	4,880,135	6,142,478	1,286,301,741
1876–'77	2,307,866	5,101,308	7,409,174	1,526,357,390
1877–'78	2,543,120	6,505,446	9,048,566	1,955,160,434
1878–'79	3,378,044	7,480,648	10,858,792	2,256,158,994
1879–'80	4,051,248	6,950,451	11,001,699	2,228,594,018
1880–'81	5,323,898	6,919,456	12,243,354	2,420,361,997
1881–'82	4,803,689	5,747,760	10,551,449	2,097,079,157

Product and export of meats.

Years.	Production of meat and lard.	Total product exported.	Exports.			Percentage exported.
			Bacon and hams.	Pork.	Lard.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
1872	1, 002, 149, 890	531, 563, 511	263, 939, 263	60, 617, 535	207, 006, 713	53. 04
1873	1, 215, 989, 506	713, 991, 729	415, 228, 587	63, 865, 621	234, 8[illegible]7, 521	58. 71
1874	1, 137, 610, 205	562, 695, 988	322, 921, 719	62, 745, 923	17[illegible], [illegible]28, 346	49. 46
1875	1, 153, 852, 707	494. 011, 756	264, 214, 959	62, 247, 881	167, 548, 916	42. 81
1876	1, 234, 614, 441	643, 904, 193	388, 218, 023	57, 838, 184	197, 847, 986	52. 15
1877	1, 316, 663, 107	750, 693, 488	444, 117, 507	68, 831, 674	237, 744, 307	57. 01
1878	1, 766, 686, 129	1, 057, 199, 200	634, 665, 610	77, 262, 061	345, 271, 529	59. 84
1879	2, 002, 917, 540	1, 209, 766, 974	773, 323, 516	93, 324, 250	343, 119, 208	60. 40
1880	2, 057, 755, 512	1, 278, 286, 090	778, 291, 729	94, 557, 703	405, 436, 658	62. 12
1881	1, 952, 307, 600	1, 129, 078, 571	692, 666, 987	101, 409, 898	335, 001, 686	57. 83

The records of packing in the East and on the Pacific coast increase the numbers slaughtered in the West about thirty per cent., making the total records of pork-packing establishments of the United States, to which must be added the number killed on farms to obtain the aggregate of swine slaughtered in the United States. The figures of pork packing are given upon the authority of Mr. Charles B. Murray, of Cincinnati. The summary is as follows:

	1881-'82.	1880-'81.
	Number.	*Number.*
Packed in the West	10, 551, 449	12, 243, 334
Packed at Buffalo, Albany, and Troy	297, 563	313, 536
Packed at New Haven, Providence, &c	250, 000	200, 000
Packed on Pacific Coast	335, 000	400, 000
Receipts at four seaboard cities	3, 371, 810	3, 396, 772
Aggregate number	14, 825, 822	16, 553, 662
Decrease in 1881-'82	1, 727, 840	....

Weight and production of the above-reported supply of hogs for the years ending March 1, 1881 and 1882.

	1881-'82.	1880-'81.
	Pounds.	*Pounds.*
Net weight of hogs	2, 839, 239, 457	3, 153, 275, 757
Decrease	314, 036, 300	....
Green meat, all kinds	1, 987, 467, 620	2, 207, 293, 030
Decrease	219, 825, 410	....
Production of lard	468, 929, 200	517, 659, 500
Decrease	48, 730, 300	....
Tierces of lard (330 pounds)	1, 420, 997	1, 568, 665
Decrease	147, 668	....

These figures represent the organized pork-packing of the country. In addition to this quantity the farmers of the packing regions and of non-packing States, East and South, kill for home supply and limited neighborhood sale about two-thirds as much more in absolute weight, and in numbers killed a larger proportion.

OUR AGRICULTURAL EXPORTS.

Statement of the exports of agricultural products of the United States, with their immediate manufactures, for the two fiscal years ending June 30, 1881, compiled from the Treasury report of commerce and navigation.

Products.	1880.		1881.	
	Quantity.	Value.	Quantity.	Value.
Animals, living:				
Hogs .... number..	83, 434	$421, 089	77, 456	$572, 138
Horned cattle .... do....	182, 756	13, 344, 195	185, 707	14, 304, 103
Horses .... do....	3, 060	675, 139	2, 523	390, 243
Mules .... do....	5, 198	532, 362	3, 207	353, 924
Sheep .... do....	209, 137	892, 647	179, 919	762, 932
All other, and fowls	....	16, 688	....	29, 058
Animal matter:				
Bone-black, ivory-black, &c .... pounds..	1, 249, 958	66, 069	1, 591, 651	51, 682
Bones and bone-dust .... cwt..	32, 680	46, 431	12, 674	34, 066
Candles .... pounds..	1, 954, 725	237, 627	1, 780, 572	210, 842
Furs and fur-skins	....	5, 404, 418	....	5, 451, 419
Glue .... pounds..	150, 718	22, 650	367, 069	59, 038
Hair:				
Unmanufactured	....	232, 726	....	295, 188
Manufactures of	....	24, 552	....	42, 033
Hides and skins, other than furs	....	649, 074	....	903, 464
Leather:				
Sole, upper and other .... pounds..	21, 834, 492	5, 086, 118	28, 690, 648	6, 472, 695
Morocco, and other fine	....	658, 242	....	661, 019
Boots and shoes .... pairs..	378, 274	441, 069	300, 968	374, 348
Saddlery and harness	....	183, 705	....	148, 567
Other manufactures	....	441, 052	....	431, 821
Oil:				
Lard .... gallons..	1, 507, 596	816, 447	836, 255	558, 576
Other animal .... do....	30, 383	23, 519	77, 496	60, 359
Provisions:				
Bacon and hams .... pounds..	759, 773, 109	50, 987, 623	746, 944, 545	61, 161, 205
Beef, fresh .... do....	84, 717, 194	7, 441, 918	106, 004, 812	9, 860, 284
salted .... do....	45, 237, 472	2, 881, 047	40, 698, 649	2, 665, 761
Butter .... do....	39, 236, 658	6, 690, 687	31, 560, 500	6, 256, 024
Cheese .... do....	127, 553, 907	12, 171, 720	147, 995, 614	16, 380, 248
Condensed milk	....	121, 013	....	139, 470
Eggs .... dozens..	85, 885	14, 148	80, 146	13, 776
Lard .... pounds..	374, 979, 286	27, 920, 367	378, 142, 496	35, 226, 575
Mutton, fresh .... do....	2, 335, 858	176, 218	3, 380, 147	258, 008
Pork .... do....	95, 949, 780	5, 930, 252	107, 928, 086	8, 272, 285
Preserved meats	....	7, 877, 200	....	5, 971, 557
Soap:				
Perfumed and toilet	....	38, 567	....	44, 496
All other .... pounds..	14, 566, 891	690, 122	13, 323, 737	650, 361
Tallow .... do....	110, 767, 627	7, 689, 232	96, 403, 372	6, 800, 628
Wax, bees' .... do....	193, 217	48, 880	164, 090	40, 208
Wool:				
Raw and fleece .... pounds..	191, 551	71, 987	71, 455	19, 217
Carpets .... yards..	8, 541	8, 530	10, 548	10, 750
Other manufactures	....	208, 046	....	320, 333
Total value of animals and animal matter	....	161, 133, 376	....	186, 258, 691
Breadstuffs and other preparations:				
Barley .... bushels..	1, 128, 923	784, 819	885, 246	549, 245
Bread and biscuits .... pounds..	14, 759, 755	686, 158	16, 116, 788	748, 490
Corn .... bushels..	98, 169, 877	53, 298, 247	91, 908, 175	50, 702, 669
Corn meal .... barrels..	350, 613	981, 361	434, 993	1, 270, 200
Oats .... bushels..	766, 366	308, 129	402, 904	186, 899
Rye .... do ...	2, 912, 754	2, 862, 765	1, 928, 437	1, 885, 813
Rye flour .... barrels..	5, 190	24, 7[illegible]	4, 453	24, 082
Wheat .... bushels..	153, 252, 795	190, 546, 305	150, 565, 477	167, 698, 485
Wheat flour .... barrels..	6, 011, 419	35, 333, 197	7, 945, 786	45, 047, 257
Other small grain and pulse	....	1, 272, 028	....	775, 799
Other preparations of grain	....	2, 439, 098	....	1, 443, 580
Rice .... pounds..	183, 534	13, 366	150, 451	10, 072
Total value of breadstuffs, &c	....	288, 050, 201	....	270, 342, 591
Cotton and its manufactures:				
Sea Island .... pounds..	5, 061, 634	1, 683, 900	7, 138, 351	2, 161, 207
Other unmanufactured .... do ...	1, 816, 999, 480	209, 852, 005	2, 183, 790, 421	245, 534, 539
Colored goods .... yards..	37, 758, 166	2, 956, 760	68, 184, 293	4, 983, 312
Uncolored .... do....	68, 821, 557	5, 834, 541	80, 399, 154	6, 624, 374
All other manufactures	....	1, 190, 117	....	1, 963, 701
Total value of cotton, &c	....	221, 517, 323	....	261, 267, 133

Statement of the exports of the agricultural products of the United States, &c.—Continued.

Products.	1880. Quantity.	1880. Value.	1881. Quantity.	1881. Value.
Wood and its products:				
Boards, planks, joists, &c ....M feet..	285, 194	$4, 223, 259	320, 602	$5, 192, 961
Laths, palings, pickets, &c ....M..	4, 039	11, 936	8, 518	22, 552
Shingles ....do..	54, 811	165, 893	60, 790	173, 026
Box-shooks	....	136, 082	....	75, 726
Other shooks, staves, and headings	....	3, 510, 976	....	3, 136, 914
Hogsheads and barrels, empty..number..	149, 230	262, 029	86, 435	155, 662
All other lumber	....	765, 550	....	1, 220, 408
Fire-wood ....cords..	3, 876	11, 552	3, 965	10, 947
Hop, hoop, telegraph, and other poles	....	427, 187	....	104, 693
Logs, masts, spars, and other whole timber	....	691, 194	....	774, 901
Timber, sawed and hewed ...cubic feet..	16, 365, 346	2, 219, 320	22, 961, 618	3, 329, 443
All other timber	....	98, 733	....	108, 576
Household furniture	....	1, 653, 878	....	1, 894, 209
Woodenware	....	331, 137	....	330, 589
All other manufactures	....	1, 728, 650	....	2, 069, 705
Ashes, pot and pearl ....pounds..	1, 231, 528	110, 578	1, 636, 839	141, 462
Bark, for tanning	....	210, 126	....	120, 436
Rosin and turpentine ....barrels..	1, 040, 345	2, 868, 180	1, 023, 710	2, 529, 423
Spirits of turpentine ....gallons..	7, 091, 200	2, 132, 154	6, 595, 528	2, 414, 719
Tar and pitch ....barrels..	41, 221	84, 728	46, 582	109, 261
Total value of wood, &c	....	21, 143, 142	....	28, 915, 724
MISCELLANEOUS.				
Brooms, brushes, &c	....	110, 410	....	152, 716
Cordage, rope, and twine of all kinds, pounds	3, 229, 875	356, 808	3, 646, 843	421, 732
Fruits:				
Apples, dried ....pounds..	3, 158, 367	192, 069	22, 623, 652	1, 247, 891
Apples, green or ripe...........bushels..	1, 121, 754	1, 190, 560	3, 071, 928	2, 301, 334
Other fruit, green, ripe, or dried	....	272, 715	....	361, 217
Preserved in cans or otherwise	....	435, 290	....	529, 277
Ginseng ....pounds..	391, 063	533, 042	338, 841	561, 545
Hay ....tons..	13, 739	206, 819	12, 662	233, 529
Hemp:				
Unmanufactured ....cwt..	1, 591	8, 796	31	431
Cables and cordage ....do....	16, 490	179, 979	10, 762	124, 895
All other manufactures	....	1, 068, 676	....	1, 060, 727
Hops ....pounds..	9, 739, 566	2, 878, 292	8, 990, 655	2, 016, 970
Liquors, alcoholic, cider and beer:				
Beer, ale and porter:				
In bottles ....dozens..	146, 739	262, 450	164, 276	292, 421
In casks ....gallons..	111, 308	36, 368	201, 376	55, 367
Spirits distilled from—				
Grain ....do....	10, 112, 598	2, 586, 685	13, 920, 984	2, 878, 388
Molasses ....do....	1, 285, 268	397, 247	839, 509	296, 448
Other materials ....do....	20, 640	43, 613	59, 160	73, 095
Wine ....do....	154, 887	123, 317	68, 181	69, 915
Oil-cake ....pounds..	453, 023, 225	6, 259, 827	448, 559, 413	6, 284, 364
Oil:				
Cotton-seed ....gallons..	6, 997, 796	3, 225, 414	3, 444, 084	1, 465, 255
Linseed ....do....	38, 431	31, 214	72, 190	48, 479
Essential or volatile	....	219, 612	....	92, 738
Seeds:				
Cotton ....pounds..	12, 142, 137	134, 116	11, 628, 799	147, 543
Clover ....do....	26, 526, 295	2, 401, 351	5, 814, 506	502, 646
Flax or lint ....do....	....	....	....	....
All other	....	241, 356	....	412, 577
Starch ....pounds..	10, 311, 736	447, 842	13, 473, 519	629, 710
Sugar:				
Brown ....pounds..	16, 858	1, 064	24, 976	2, 045
Refined ....do....	30, 125, 146	2, 717, 563	22, 227, 857	2, 049, 962
Molasses ....gallons..	3, 596, 010	539, 603	2, 214, 467	548, 617
Candy and confectionery	....	81, 757	....	73, 253
Tobacco:				
Leaf ....pounds..	215, 910, 187	16, 379, 107	227, 026, 605	18, 737, 043
Cigars ....M..	2, 583	67, 821	3, 546	94, 559
Snuff ....pounds..	15, 883	6, 074	16, 841	8, 710
Other manufactures	....	1, 989, 271	....	2, 038, 572
Vegetables, &c.:				
Onions ....bushels..	55, 152	50, 074	29, 374	37, 975
Pickles and sauces	....	17, 158	....	21, 157
Potatoes ....bushels..	696, 080	522, 039	638, 840	460, 517
All other	....	89, 053	....	64, 246
Vinegar ....gallons..	16, 534	4, 123	42, 317	9, 722
Total value of miscellaneous products .	....	46, 018, 575	....	46, 407, 608

Statement of the exports of agricultural products of the United States, &c.—Continued.

RECAPITULATION.

Products.	1871.	1872.	1873.	1874.
Animals and animal matter	$47, 010, 812	$77, 060, 849	$99, 806, 599	$99, 697, 669
Breadstuffs, &c	79, 519, 387	85, 155, 523	98, 762, 891	161, 225, 939
Cotton, &c	221, 885, 245	182, 988, 925	230, 190, 597	214, 819, 420
Wood, &c	15, 820, 029	21, 425, 068	25, 854, 120	27, 675, 300
Miscellaneous	83, 060, 081	40, 139, 296	87, 901, 458	45, 486, 626
Total agricultural exports	397, 205, 054	406, 769, 661	492, 515, 665	548, 814, 954
Total exports	562, 518, 651	549, 219, 718	649, 132, 563	693, 039, 066
Per cent. of agricultural matter	70	74	76	79

Products.	1875.	1876.	1877.	1878.
Animals and animal matter	$104, 314, 988	$113, 941, 509	$140, 564, 066	$145, 587, 515
Breadstuffs, &c	111, 478, 096	131, 212, 471	118, 126, 940	181, 811, 794
Cotton, &c	194, 710, 507	200, 382, 240	183, 253, 248	191, 470, 144
Wood, &c	22, 875, 814	21, 620, 486	23, 422, 966	21, 747, 107
Miscellaneous	45, 294, 411	46, 079, 567	58, 652, 719	52, 245, 306
Total agricultural exports	478, 673, 816	513, 236, 273	524, 019, 939	592, 861, 876
Total exports	643, 694, 767	644, 956, 406	689, 167, 390	722, 811, 815
Per cent. of agricultural matter	74	79	76	82

Products.	1879.	1880.	1881.
Animals and animal matter	$146, 640, 233	$161, 138, 376	$186, 258, 691
Breadstuffs, &c	210, 391, 066	288, 050, 201	270, 342, 591
Cotton, &c	173, 158, 200	221, 517, 823	261, 267, 183
Wood, &c	20, 122, 967	21, 143, 142	23, 915, 724
Miscellaneous	53, 843, 026	46, 018, 575	46, 407, 608
Total agricultural exports	604, 155, 402	737, 862, 617	788, 191, 747
Total exports	717, 093, 777	823, 946, 353	883, 925, 947
Per cent. of agricultural matter	84	89. 5+	89. 2—

MARKET PRICES OF FARM

The following quotations represent as nearly as practicable

Products.	January.	February.	March.	April.	May.
NEW YORK.					
Flour:					
Superfine.........bbl.	$2 75 to $3 80	$3 00 to $4 00	$3 75 to $4 10	$3 80 to $4 10	$4 00 to $4 40
Springwheat extras.do.	4 15 to 6 25	4 25 to 6 50	4 40 to 6 25	4 40 to 6 25	4 60 to 6 25
Wint'rwheat extras.do.	4 35 to 6 25	4 50 to 6 50	4 50 to 6 50	4 50 to 6 50	4 65 to 6 50
Patents.............do.	6 50 to 8 50	6 50 to 8 50	6 50 to 8 25	6 50 to 8 25	6 50 to 8 25
Southern extras and family..........bbl.	4 50 to 7 00	4 75 to 7 00	4 75 to 6 75	4 75 to 6 75	4 75 to 6 75
Wheat:					
Spring...........bush.	1 14 to 1 17	1 14 to 1 17	1 10 to 1 18	1 12 to 1 22	1 12 to 1 26
Winter.............do..	1 12 to 1 18	1 14 to 1 25	1 12 to 1 26	1 14 to 1 29	1 15 to 1 27½
White..............do..	1 10 to 1 16	1 13 to 1 18	1 14 to 1 20	1 14 to 1 24	1 15 to 1 26
Barley..................do..	1 00 to 1 35	90 to 1 35	85 to 1 27	1 05 to 1 22	1 00 to 1 15
Corn....................do..	53 to 58	52 to 59	56 to 65	56 to 60	60 to 65
Oats....................do..	42 to 48	42 to 48	42 to 48	43 to 50	44 to 52
Rye.....................do..	95 to 98	97 to 1 02	98 to 1 03	1 04 to 1 07	1 10 to 1 14
Potatoes..............bbl.	1 50 to 2 25	2 00 to 2 50	2 00 to 2 35	1 75 to 2 75	2 00 to 3 00
Hay:					
Baled, 1st quality..ton.	23 00 to 26 00	24 00 to 25 00	23 00 to 24 00	24 00 to 25 00	20 00 to 25 00
Baled, 2d quality...do..	19 00 to 22 00	21 00 to 22 00	20 00 to 23 00	22 00 to 23 00	18 00 to 21 00
Beef:					
Plain mess..........bbl.	8 50 to 9 00	9 00 to 9 50	9 25 to 9 50	9 50 to 9 75	9 50 to 9 75
Extra mess.........do..	9 50 to 10 00	10 50 to 11 00	10 80 to 11 00	11 00 to 11 75	11 00 to 11 75
Hams...............do..	17 00 to 17 50	19 50 to 20 00	21 00 to 22 00	21 00 to 22 50	22 50 to 23 00
Pork:					
Extra prime.......bbl.	10 50 to	10 75 to 11 00	11 50 to 12 00	12 00 to 12 25	13 50 to 14 00
Prime mess.........do..	11 00 to 12 00	13 50 to 14 00	14 00 to 15 50	15 00 to 16 00	16 00 to 17 00
Lard...............cental.	8 85 to 9 25	9 80 to 10 00	9 60 to 10 70	10 95 to 11 15	11 00 to 11 85
Butter:					
Western..............lb.	14 to 28	14 to 27	18 to 26	13 to 27	13 to 30
State.................do.	22 to 34	22 to 34	18 to 34	14 to 32	18 to 24
Cheese:					
State factory.........lb.	8½ to 13	8½ to 13½	8 to 13½	8½ to 13½	8½ to 13
Western factory....do.	8½ to 12½	8½ to 13½	8 to 12½	7 to 12	8 to 13
Sugar, fair to prime refining..............lb.	6¾ to 7⅝	7½ to 7⅝	7¼ to 7½	7½ to 7¼	7¼ to 7½
Cotton:					
Ordinary to good ordinary..............lb.	8⅝ to 10⅝	8 11/16 to 10 9/16	7 13/16 to 9 11/16	7 to 9⅛	6 15/16 to 8 11/16
Low middling to good middling..........lb.	11 7/16 to 12⅝	11⅜ to 12 9/16	10⅝ to 12½	10 to 11 11/16	9 15/16 to 11⅜
Tobacco:					
Common to good leaf, New England.....lb.	13 to 20	13 to 25	13 to 25	13 to 25	13 to 25
Common to good leaf, New York and Pennsylvania..........lb.	8 to 16	8 to 16	8 to 16	8 to 20	8 to 18
Common to good leaf, Ohio and Wisconsin.................lb.	7½ to 14	7½ to 12	7 to 12	6 to 12	6 to 9
Common to good leaf, Southern..........lb.	6 to 10½	5½ to 10½	5 to 10½	5 to 10½	5 to 8½
Lugs, Virginia.......do.	4 to 5½	4 to 5	4 to 5	4 to 5½	4 to 5
Lugs, Kentucky....do.	4½ to 6	4½ to 6	4½ to 6	4½ to 6	4½ to 6½
Wool:					
American XXX and picklock..........lb.	49 to 51	48 to 50	46 to 48	44 to 46	43 to 45
American X and XX.do.	37 to 48	40 to 48	38 to 45	32 to 42	32 to 42
American combing..do.	43 to 52	45 to 52	45 to 50	40 to 46	37 to 45
Pulled...............do.	21 to 46	21 to 45	21 to 45	20 to 38	20 to 38
California..........do.	14 to 38	17 to 38	14 to 36	15 to 25	14 to 30
CINCINNATI.					
Flour:					
Superfine..........bbl.	3 50 to 3 85	3 40 to 3 75	3 40 to 3 75	3 35 to 3 75	3 40 to 3 75
Extra..............do..	4 10 to 4 35	4 10 to 4 40	4 10 to 4 40	4 10 to 4 40	4 20 to 4 50
Family.............do..	4 60 to 4 90	4 75 to 4 95	4 75 to 5 00	4 70 to 5 00	4 85 to 5 15
Fancy..............do..	5 10 to 6 00	5 10 to 5 75	5 25 to 5 75	5 25 to 6 00	5 35 to 6 00
Wheat:					
Amber.............bush.	1 02 to 1 03	1 04 to 1 06	1 01 to 1 03	1 06 to 1 09	1 09 to 1 10
White...............do..	....	....	....	....	....
Red winter........do..	1 03 to 1 05	1 06 to 1 07	1 04 to 1 07	1 07 to 1 10	1 11 to 1 14
Corn................do..	41 to 44	42 to 44	43 to 45	46 to 48	48 to 52
Rye.................do..	95 to 96	97 to 98	1 03 to 1 05	1 11 to 1 12	1 21 to 1 22
Barley..............do..	75 to 98	70 to 1 00	87 to 1 03	95 to 1 08	95 to 1 10
Oats................do..	32 to 38	35 to 39	35 to 38	36 to 40	38 to 41
Hay:					
Baled, No. 1.......ton..	16 00 to 16 50	17 00 to 18 00	15 50 to 16 50	16 50 to 17 50	20 00 to 21 00
Lower grades......do..	11 00 to 15 00	11 00 to 16 00	10 00 to 15 00	11 00 to 15 50	13 00 to 18 00

PRODUCTS FOR 1881.

the state of the market at the beginning of each month.

June.	July.	August.	September.	October.	November.	December.
$4 10 to $4 60	$4 00 to $4 50	$4 20 to $4 60	$5 00 to $6 00	$5 50 to $6 25	$4 70 to $5 25	$4 50 to $5 15
4 50 to 6 50	4 70 to 6 75	4 75 to 6 75	6 00 to 7 50	6 40 to 8 00	5 35 to 7 00	5 25 to 6 75
4 80 to 6 75	4 80 to 7 25	5 00 to 7 25	6 40 to 7 75	6 70 to 8 25	5 60 to 7 25	5 50 to 7 00
6 50 to 8 25	6 50 to 8 50	6 00 to 8 00	7 00 to 9 00	8 00 to 9 50	6 50 to 8 50	6 50 to 8 50
5 35 to 7 00	5 40 to 7 50	5 40 to 7 50	6 50 to 8 00	7 00 to 8 50	5 75 to 7 50	5 75 to 7 25
1 12 to 1 24	1 05 to 1 25	1 08 to 1 23	1 20 to 1 88	1 25 to 1 47	1 25 to 1 42	1 22 to 1 40
1 15 to 1 29	1 15 to 1 32	1 12 to 1 28	1 30 to 1 46	1 40 to 1 55	1 30 to 1 44	1 32 to 1 45
1 16 to 1 25	1 17 to 1 28	1 15 to 1 26	1 30 to 1 43	1 40 to 1 52	1 33 to 1 42	1 35 to 1 42
1 00 to 1 12	....	....	1 10 to 1 15	1 15 to 1 25	97 to 1 13	88 to 1 12
47 to 66	58 to 62	48 to 60	63 to 79	70 to 89	65 to 73	67 to 74
43 to 51	42 to 47	44 to 49	41 to 51	41 to 53	45 to 53	46 to 54
1 08 to 1 12	1 05 to 1 08	84 to 89	1 07 to 1 12	1 05 to 1 10	1 00 to 1 05	97 to 1 01
1 50 to 3 00	1 50 to 2 00	1 25 to 1 75	2 00 to 3 00	2 25 to 3 00	2 25 to 3 00	2 50 to 3 15
20 00 to 22 00	19 00 to 20 00	19 00 to 20 00	20 00 to 21 00	20 00 to 23 00	20 00 to 23 00	20 00 to 22 00
17 00 to 20 00	16 00 to 18 00	15 00 to 17 00	14 00 to 17 00	12 00 to 18 00	14 00 to 19 00	15 00 to 19 00
11 00 to 12 00	12 00 to 12 50	12 50 to 13 00	12 50 to 13 00	12 00 to 12 50	12 00 to 12 25	11 50 to 12 00
12 00 to 13 00	12 50 to 13 50	13 50 to 14 25	13 50 to 14 00	12 50 to 13 00	12 25 to 13 00	13 00 to 14 00
23 00 to 24 00	23 50 to 24 50	22 00 to 23 50	22 00 to 23 00	22 00 to 23 00	20 00 to 21 00	20 00 to 21 00
13 00 to 13 50	14 00 to 14 50	14 50 to 15 00	15 00 to 15 50	16 00 to 16 75	15 50 to 15 75	14 00 to 14 25
15 50 to 16 00	15 75 to 16 00	15 75 to 16 75	16 50 to 17 50	17 00 to 18 00	16 50 to 17 00	16 00 to 17 00
10 10 to 11 10	9 40 to 11 60	10 15 to 12 00	11 10 to 12 10	11 90 to 12 85	11 15 to 12 00	10 85 to 11 60
10 to 22	10 to 19	10 to 19	10 to 25	12 to 28	18 to 30	14 to 35
18 to 25	17 to 23	17 to 24	22 to 31	22 to 36	25 to 36	31 to 42
6½ to 10	7 to 10	7½ to 10¾	9 to 12	9 to 13	9 to 13	8 to 12½
3½ to 9½	3 to 9½	3 to 10	3 to 11	3 to 11½	3 to 12	3 to 11
7⅛ to 7½	7⅞ to 8	7⅝ to 8	7⅝ to 7¾	8 to 8½	8⅛ to 8⅝	7⅞ to 8⅛
7⅜ to 9½	7¾ to 9⅛	8 11/16 to 10⅛	9 1/16 to 10⅞	8⅝ to 10⅜	8¾ to 10⅜	9⅜ to 11 1/16
10½ to 11 11/16	10⅜ to 11 13/16	11 7/16 to 12⅞	11 5/16 to 13⅛	11⅝ to 12⅜	11 5/16 to 12⅛	11⅝ to 12⅜
13 to 25	13 to 25	13 to 25	13 to 25	13 to 25	13 to 25	13 to 25
8 to 18	8 to 18	8 to 18	8 to 18	8 to 18	8 to 18	8 to 15
6 to 9	7 to 9	5 to 9	5½ to 12	5 to 12	6 to 11	6 to 10
5 to 10½	5 to 10	6 to 10	4½ to 12½	4½ to 12½	5½ to 10⅜	4½ to 12
4 to 5	4 to 5	4 to 5	4 to 5	6 to 9	6 to 9	6 to 9
4½ to 6½	4½ to 6½	4½ to 6½	7 to 8½	7 to 8½	7 to 8¾	6½ to 8
43 to 45	43 to 45	43 to 45	43 to 45	45 to 46	45 to 46	44 to 45
32 to 41	34 to 42	34 to 43	34 to 43	36 to 45	36 to 45	37 to 45
36 to 45	36 to 45	36 to 46	36 to 46	39 to 48	39 to 48	42 to 50
20 to 40	20 to 40	20 to 36	20 to 40	20 to 42	20 to 41	20 to 45
14 to 30	14 to 24	14 to 30	14 to 30	14 to 31	15 to 30	12 to 24
3 65 to 4 10	4 00 to 4 40	4 35 to 4 65	5 40 to 5 85	6 00 to 6 50	5 50 to 5 85	5 15 to 5 40
4 50 to 4 85	4 70 to 5 00	5 10 to 5 35	6 25 to 6 60	6 75 to 7 00	6 10 to 6 85	5 60 to 5 90
5 10 to 5 30	5 25 to 6 35	5 75 to 6 00	6 75 to 7 00	7 20 to 7 75	6 50 to 7 75	6 30 to 7 00
5 45 to 6 25	5 85 to 6 50	6 25 to 6 85	7 25 to 7 75	7 60 to 8 00	7 10 to 7 75	7 00 to 7 75
1 13 to 1 14	1 14 to 1 15	1 15 to 1 20	1 35 to 1 36	1 36 to 1 48	1 30 to 1 41	1 35 to 1 39
1 15 to 1 16	1 15 to 1 20	1 15 to 1 25	1 28 to 1 38	1 37 to 1 50	1 30 to 1 41	1 33 to 1 40
47 to 54	46 to 53	53 to 59	65 to 75	69 to 80	57 to 68	62 to 67
1 19 to 1 23	99 to 1 00	82 to 85	1 10 to 1 12	1 16 to 1 17	1 08 to 1 12	1 02 to 1 03
85 to 1 02	70 to 90	75 to 92	95 to 1 10	1 05 to 1 18	92 to 1 17	97 to 1 15
40 to 43	30 to 42	37 to 40	43 to 45	45 to 46	43 to 47	46 to 50
15 00 to 16 00	13 00 to 14 00	15 00 to 16 00	17 00 to 18 00	19 00 to 20 00	17 00 to 18 00	19 00 to 21 00
9 50 to 11 00	7 00 to 12 00	9 00 to 13 00	10 00 to 16 00	13 00 to 18 00	12 00 to 16 00	13 00 to 18 00

MARKET PRICES OF FARM

Product.	January.	February.	March.	April.	May.
CINCINNATI—Cont'd.					
Pork:					
Mess ....bbl.	$12 75 to $12 75	$13 25 to $14 50	$14 75 to $15 00	$14 75 to $15 50	$17 25 to $17 50
Sugar-cured hams...lb.	9¼ to 10½	9¾ to 10½	9¾ to 10¼	9½ to 10¾	10 to 11¼
Sugar-cured bacon..do.	9 to 9½	9½ to 10	9¾ to 10½	9¾ to 10½	9¾ to 10¼
Sugar-cured shoulders, pound	6¼ to 6½	6¼ to 66½	7 to 7½	7 to 7½	6½ to 6¾
Lard ....cental.	8 40 to 8 50	9 50 to 9 55	9 90 to 9 95	10 40 to 10 50	10 90 to 11 00
Butter:					
Choice to fancy grades, pound	30 to 39	24 to 36	23 to 36	25 to 37	22 to 28
Prime to medium grades ....lb.	15 to 30	17 to 21	15 to 21	15 to 24	15 to 18
Cheese:					
Prime to choice factory, pound	12 to 12½	12 to 13	12 to 12½	12 to 13	10 to 11
Lower grades........lb.	10 to 11½	11 to 11½	11 to 11½	11 to 11½	9 to 10
Potatoes ....bush.	50 to 80	75 to 85	75 to 90	80 to 1 00	1 00 to 1 20
Peanuts:					
Tennessee ....lb.	2¾ to 4	2½ to 4	2½ to 3¾	2½ to 3¾	2½ to 4
Virginia........do.	4¼ to 4½	4¼ to 4½	4¼ to 4½	4¼ to 4½	4¼ to 4½
Cotton:					
Ordinary to good ordinary ....lb.	8¼ to 8⅝	8½ to 9⅝	8 to 9⅛	6⅞ to 8⅛	6¼ to 7⅞
Low middling to good middling........lb.	10⅝ to 11⅞	10½ to 11¾	10¼ to 11⅝	9¼ to 10⅞	9 to 10⅝
Middling fair to fair.do.	12¼ to 13	12⅛ to 12⅞	12⅛ to 13	11⅝ to 12⅜	11⅜ to 12¼
Wool:					
Fleece-washed ....lb.	40 to 43	38 to 42	36 to 41	35 to 38	33 to 38
Tub-washed........do.	35 to 46	35 to 45	33 to 44	28 to 42	28 to 37
Unwashed........do.	25 to 32	23 to 31	21 to 28	20 to 25	18 to 25
Pulled........do.	32 to 38	30 to 31	30 to 31	27 to 28	27 to 28
SAN FRANCISCO.					
Flour:					
Superfine........bbl	3 50 to 4 00	2 65 to 3 75	2 75 to 4 25	2 75 to 3 00	2 75 to 4 00
Extras ....do..	5 00 to 5 25	4 50 to 5 00	4 50 to 4 75	4 25 to 4 50	4 25 to 5 00
Fancy ....do..	5 25 to 5 50	5 00 to 5 25	4 75 to 5 00	4 75 to 5 00	4 75 to 5 25
Wheat:					
California ....cental.	1 30 to 1 50	1 10 to 1 40	1 20 to 1 40	1 20 to 1 40	1 20 to 1 40
Oregon ....do..	1 40 to 1 45	1 30 to 1 35	1 30 to 1 35	1 30 to 1 40	1 30 to 1 35
Barley ....do..	1 00 to 1 25	85 to 1 15	75 to 1 25	90 to 1 25	85 to 1 20
Corn ....do..	1 00 to 1 05	1 05 to 1 15	1 00 to 1 15	1 00 to 1 40	1 00 to 1 20
Oats ....do..	1 25 to 1 50	1 15 to 1 35	1 25 to 1 50	1 40 to 1 65	1 40 to 1 65
Potatoes........bush..	60 to 1 00	40 to 90	60 to 1 10	85 to 1 35	80 to 1 25
Hay ....ton..	10 00 to 15 00	8 00 to 15 00	8 00 to 14 50	8 50 to 15 00	8 50 to 13 50
Pork:					
Mess ....bbl.	20 00 to 21 00	20 00	18 00 to 20 00	18 00 to 20 00	18 00 to 20 00
Prime mess ....do..	12 00 to 12 50	12 00 to 12 50	12 00 to 12 50	12 50 to 13 00	12 50 to 13 00
Bacon, domestic ....lb.	10 to 12	10 to 12	12 to 13	12 to 13	12 to 13
Hams ....do.	12 to 16	12 to 16	12 to 14	12 to 14	12 to 14
Beef:					
Mess ....bbl.	10 00 to 11 00	10 00 to 11 00	10 00 to 10 50	10 00 to 10 50	10 00 to 10 50
Family mess.....½ bbl.	7 00 to 7 50	7 00 to 7 50	7 50 to 8 00	7 50 to 8 00	7 50 to 8 00
Lard........lb.	10 to 12	10 to 12	10 to 12	10 to 12	10 to 12
Butter:					
Overland & Eastern.lb.	16 to 25	16 to 25	16 to 25	15 to 18	15 to 18
Oregon ....do.	19 to 20	19 to 21	20	18 to 20	18 to 20
California ....do.	35 to 40	30 to 35	30 to 35	20 to 23	20 to 22
Cheese ....do.	13 to 16	13 to 16	13 to 16	13 to 16	13 to 16
Wool:					
Native ....do.	12 to 20	12 to 20	12 to 20	12 to 18	12 to 18
California ....do.	20 to 28	20 to 28	20 to 28	18 to 20	20 to 27
Oregon ....do.	20 to 28	20 to 28	20 to 28	20 to 25	20 to 27
NEW ORLEANS.					
Flour:					
Superfine........bbl.	3 50 to 3 75	3 50 to 4 00	Nominal.	3 00 to 3 25	3 00 to 3 25
Extra ....do..	3 75 to 4 50	4 00 to 5 00	4 25 to 5 00	3 50 to 5 25	3 25 to 5 00
Family and fancy..do..	4 85 to 6 00	5 25 to 6 35	5 25 to 6 25	5 40 to 6 25	5 25 to 6 25
Patents ....do..	5 75 to 8 00	5 90 to 8 50	5 75 to 8 00	6 00 to 8 25	6 00 to 8 00
Wheat........bush.	1 17 to 1 18	1 17 to 1 18	1 17	1 17	1 20
Corn ....do..	52 to 55	52 to 54	60 to 63	51 to 63	51 to 67
Oats ....do..	46 to 48	46 to 47	45 to 60	48 to 50	47 to 48
Potatoes........bbl.	2 40 to 2 75	2 65 to 3 10	2 60 to 2 75	2 50 to 3 00	2 75 to 3 00
Hay:					
Prime ....ton.	22 00 to 23 00	24 00 to 25 00	23 00 to 24 00	24 00 to 25 00	25 00 to 26 00
Choice ....do..	23 00 to 24 00	25 00 to 26 00	24 00 to 26 00	25 00 to 26 00	26 00 to 27 00

PRODUCTS FOR 1881—Continued.

June.	July.	August.	September.	October.	November.	December.
$16 50 to $17 00	$16 75 to $17 00	$18 25 to $18 50	$19 75 to $20 00	$20 75 to $21 00	$18 75 to $19 00	$17 50 to $18 00
10 to 11	11 to 11½	12½ to 13	13 to 13½	14½ to 14¾	13½ to 13¾	12½ to 13
9¾ to 10½	9¾ to 10	10 to 10½	12 to 12½	13 to 13½	13 to 13½	12¼ to 12½
6½ to 6¾	6¾ to 7	7½ to 7¾	9 to 9½	9½ to 9½	9 to 9½	8 to 8½
10 40 to 10 60	10 50 to 11 00	11 00 to 11 25	10 75 to 11 25	11 75 to 12 25	11 25 to 11 35	10 80 to 11 20
13 to 23	18 to 24	20 to 25	24 to 30	27 to 37	27 to 37	28 to 40
12 to 14	12 to 15	12 to 18	16 to 24	18 to 25	17 to 26	20 to 28
7½ to 9	8½ to 9	9½ to 10½	11½ to 12	13 to 14	12 to 13	11½ to 12½
6 to 7	7½ to 8	7 to 8	7 to 9	8 to 10	7 to 8	6 to 7½
1 20 to 1 40	1 00 to 1 05	95 to 1 00	1 10 to 1 20	1 05 to 1 10	1 00 to 1 15	1 05 to 1 20
1½ to 3½	2½ to 4	3 to 5	4 to 5½	5½ to 6½	4½ to 6	4½ to 6
4 to 4½	4½ to 4½	4½ to 5½	5 to 6½	6½ to 8	6 to 7½	6 to 7½
6¾ to 8½	7½ to 8⅝	7⅜ to 9½	7⅝ to 9	8½ to 9½	8½ to 10	8⅜ to 10⅜
9½ to 11	8⅞ to 11⅜	11 to 12½	10⅞ to 12½	10⅞ to 12	10⅜ to 11⅝	11 to 11⅞
12 to 12¾	12½ to 13½	13½ to 14	13⅛ to 13⅞	12⅝ to 13⅛	12⅝ to 13⅛	12⅝ to 13⅝
33 to 37	35 to 37	35 to 37	35 to 37	35 to 38	35 to 38	35 to 38
28 to 37	28 to 38	28 to 38	28 to 39	28 to 39	28 to 39	28 to 39
18 to 25	18 to 26	18 to 26	18 to 26	18 to 27	18 to 27	18 to 27
27 to 28	28 to 30	28 to 30	28 to 29	28 to 30	28 to 30	28 to 30
2 75 to 4 00	2 75 to 3 50	2 75 to 3 50	4 00 to 4 25	4 00 to 4 25	4 00 to 4 25	4 00 to 4 25
4 25 to 5 00	4 00 to 4 75	4 25 to 5 00	5 00 to 5 35	5 00 to 5 35	5 00 to 5 35	4 50 to 4 75
4 75 to 5 25	4 75 to 5 00	4 50 to 5 25	5 25 to 5 50	5 25 to 5 50	5 35 to 5 50	5 00 to 5 50
1 20 to 1 42	1 20 to 1 45	1 32 to 1 51	1 65 to 1 70	1 65 to 1 70	1 70 to 1 77½	1 70
1 30 to 1 35	1 30 to 1 42	1 40 to 1 46	1 60 to 1 67½	1 60 to 1 65	1 70 to 1 75	1 66 to 1 67
80 to 1 20	90 to 1 20	92½ to 1 15	1 13½ to 1 25	1 35 to 1 50	1 40 to 1 57½	1 42½ to 1 50
1 00 to 1 15	1 00 to 1 15	1 00 to 1 15	1 15 to 1 22½	1 52½ to 1 60	1 25 to 1 35	1 42½ to 1 50
1 40 to 1 75	1 50 to 1 75	1 55 to 1 62½	1 45 to 1 65	1 35 to 1 62½	1 45 to 1 65	1 52½ to 1 75
50 to 1 50	25 to 90	60 to 1 00	1 00 to 1 25	75 to 1 30	75 to 1 30	70 to 1 40
7 50 to 11 50	7 00 to 11 00	6 00 to 11 50	7 00 to 12 00	8 00 to 13 00	8 00 to 14 00	10 00 to 15 00
18 00 to 20 00	18 00 to 20 00	23 00	22 50	21 00 to 22 00	19 00	21 00 to 22 00
12 50 to 13 00	12 50 to 13 00	16 00	16 00	18 50 to 19 00	16 00	18 50 to 19 00
12 to 13	11 to 12½	12½ to 14	13 to 14½	14 to 16	14½ to 16	13 to 14½
12 to 14	10 to 14	11 to 15	11 to 15½	13 to 17	13 to 17	13½ to 17½
10 00 to 10 50	10 00 to 10 50	10 00 to 12 75	9 00 to 10 50	9 00 to 9 50	9 00	9 00 to 9 50
7 50 to 8 00	7 50 to 8 00	7 75 to 8 25	7 75 to 8 00	7 00 to 7 50	7 00	6 00 to 6 50
10 to 12	10 to 12	12½ to 14	10 to 14½	10 to 16½	14 to 15½	14 to 16½
15 to 18	15 to 20	20 to 25	20 to 25	20 to 25	20 to 25	20 to 25
18 to 20	18 to 20	27 to 32½	27½ to 32½	32½ to 35	40 to 42½	32½ to 35
20 to 24	24 to 27	32½ to 35	32 to 35	37½ to 40	45 to 47½	37½
10 to 15	10 to 13	12 to 19	12 to 19	12 to 18	12 to 18	14 to 18
15 to 18	15 to 18	16 to 17	15 to 16	11 to 13	11 to 13	10 to 13
20 to 27	20 to 27	18 to 25	25 to 27	11 to 14	12½ to 14	10 to 14
20 to 27	20 to 30	24 to 26	27 to 30	17 to 20	17 to 20	16 to 21
3 00 to 3 15	3 00 to 3 10	3 25 to 3 50	4 50 to 5 00	5 00 to 5 50	5 00 to 5 25	4 75 to 5 00
3 25 to 5 00	3 25 to 5 25	3 75 to 5 25	5 50 to 7 00	5 50 to 7 25	5 50 to 6 50	5 00 to 6 25
5 25 to 6 40	5 35 to 6 50	5 75 to 6 75	7 25 to 8 25	7 50 to 8 25	6 85 to 7 90	6 25 to 7 75
6 00 to 8 00	6 00 to 8 25	7 00 to 8 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	7 50 to 8 75
1 25 to 1 26	1 27 to 1 28	1 28 to 1 29	1 42 to 1 48	1 51 to 1 52	Nominal.	Nominal.
53 to 67	54 to 68	55 to 67	72 to 85	74 to 95	78 to 88	71 to 82
47 to 48	44 to 45	50 to 55	55 to 56	53 to 55	54 to 58	54 to 57
2 25 to 2 50	1 25 to 1 75	2 50 to 2 75	3 25 to 3 50	4 00 to 4 25	3 25 to 3 50	3 50 to 4 00
22 00 to 23 00	18 00 to 18 50	16 00 to 17 00	22 00 to 23 00	19 00 to 20 00	24 00 to 25 00	24 00 to 25 00
23 00 to 24 00	19 00 to 20 00	18 00 to 19 00	25 00 to 26 00	21 00 to 23 00	26 00 to 27 00	26 00 to 27 00

MARKET PRICES OF FARM

Product.	January.	February.	March.	April.	May.
NEW ORLEANS—Cont'd.					
Beef:					
Western mess .....bbl	$9 00 to $10 00	$9 00 to $11 00	$9 00 to $11 00	$11 00 to $12 00	$12 50 to $14 00
Fulton market...½ bbl.	6 00 to 6 50	8 25	8 25	8 25 to 8 50	8 25 to 8 50
Pork:					
Mess ....bbl.	12 75 to 13 50	14 50 to 15 25	15 50 to 16 00	15 50 to 16 00	16 50 to 18 50
Bacon and shoulders, pound	5⅞ to 8½	6 to 8⅜	6⅞ to 9	6 to 9½	7 to 10½
Hams...............lb.	9 to 10½	9 to 10½	10½ to 11	10 to 11	10 to 11
Lard ....do.	8⅞ to 10	10 to 11	10½ to 10½	10½ to 11½	11½ to 12
Butter:					
Creamery ....do.	30 to 36	28 to 31	31 to 36	28 to 37	22 to 32
Prime to choice dairy, pound	23 to 28	22 to 25	22 to 25	22 to 26	18 to 22
Cheese:					
Choice factory......lb.	12 to 13	12 to 13	11 to 11½	13 to 13½	11 to 12
English dairy.......do.	15 to 16	15 to 16	15 to 16	15 to 16	15 to 16
Skims ....do.	6½ to 10	7 to 11	6 to 11	9 to 12	5 to 9
Sugar:					
Fair to fully fair ....lb.	6 to 6⅜	6½ to 6⅜	6½ to 6⅝	6½ to 6⅞	7½ to 7⅞
Prime to strictly prime, pound	6½ to 6⅞	6½ to 6⅞	6⅞ to 6⅞	6⅞ to 7½	7⅞ to 8
Clarified ....lb.	7⅞ to 8⅝	7⅞ to 8⅜	7⅞ to 8⅜	8⅝ to 9	8⅝ to 9½
Cotton:					
Low ordinary........lb.	7⅞ to 8	7½ to 7⅞	6⅞ to 7	5⅝ to 5⅞	5⅞ to 6
Ordinary to good ordinary ....lb.	8⅞ to 10½	8⅝ to 9⅝	7⅞ to 9⅝	6⅝ to 8⅜	6⅞ to 8½
Low middling to good middling..........lb.	11 to 12⅝	10⅞ to 12⅞	9⅞ to 11⅞	9 to 11⅞	9 to 11½
Middling fair ....do.	13 to 13⅞	13⅜ to 13⅞	13 to 13⅞	12⅝ to 12⅞	11⅜ to 12½
Tobacco:					
Lugs ....lb.	4½ to 4⅞	4½ to 4⅞	4½ to 4⅞	4½ to 4⅞	4½ to 4⅞
Low to medium leaf, pound	5½ to 7	5½ to 7	5½ to 7	5½ to 7	5½ to 7
Wool:					
Louisiana clear .....lb.	27 to 28	28 to 28½	26 to 27	24 to 25	18 to 19
Lake ....do.	29 to 30	29 to 30	28 to 29	26 to 27	20 to 21
Burry ....do.	13 to 16	13 to 15	12 to 15	10 to 15	10 to 13
Peanuts ....do.	4 to 5½	4½ to 6	4 to 4½	4 to 6	4 to 5½
Rice:					
Common to good....lb.	4⅞ to 5⅝	4 to 5⅝	4½ to 5⅞	4 to 5½	3⅞ to 5½
Prime to choice.....do.	5⅞ to 6½	5⅞ to 6½	6 to 6½	5⅝ to 6	5⅝ to 6
CHICAGO.					
Flour:					
Winters ....bbl.	5 00 to 6 00	5 00 to 6 00	5 00 to 6 00	5 00 to 6 00	4 50 to 6 00
Extras ....do..	4 50 to 5 25	4 25 to 5 25	4 00 to 5 50	4 50 to 5 25	4 25 to 4 75
Superfine..........do..	3 00 to 3 50	3 25 to 3 75	3 00 to 3 75	2 80 to 3 50	2 50 to 3 50
Wheat:					
Spring............bush.	85 to 99	84 to 1 00	87 to 1 00	86 to 1 08	91 to 1 03
Winter.............do..	50 to 1 03	98 to 99	97 to 1 01	1 02 to 1 03	1 01 to 1 09
Barley ....do..	59 to 1 13	77 to 1 08	80 to 1 08	84 to 98	87 to 1 05
Corn ....do..	33 to 37	33 to 37	37 to 39	35 to 41	39 to 43
Oats...............do..	29 to 37	29 to 30	30 to 32	30 to 37	34 to 37
Rye ....do..	85 to 89	84 to 89	85 to .96	99 to 1 08	1 14 to 1 15
Potatoes ....do..	60 to 70	60 to 75	75 to 90	83 to 90	90 to 1 00
Hay:					
Timothy ....ton.	13 50 to 15 00	13 00 to 14 00	13 00 to 14 50	14 00 to 15 50	15 50 to 17 50
Prairie ....do..	8 00 to 11 00	7 00 to 11 00	9 00 to 13 50	9 50 to 12 50	10 00 to 12 00
Beef:					
Mess ....bbl.	7 50 to 8 00	7 50 to 8 00	8 50 to 9 00	10 00 to 10 25	10 25 to 10 50
Extra mess..........do..	8 50 to 9 00	8 50 to 9 00	9 50 to 10 00	10 75 to 11 00	11 25 to 11 50
Hams ....do..	15 00 to 16 00	19 50 to 20 00	21 00 to 21 50	20 00 to 20 50	21 50 to 22 50
Pork:					
Mess ....do..	12 80 to 12 85	14 40 to 14 50	14 50 to 14 65	15 50 to 15 65	17 45 to 17 50
Bacon ....lb.	4⅞ to 7	5½ to 8½	5½ to 8½	5½ to 8½	6⅞ to 9⅞
Hams ....do.	8½ to 9	9½ to 9⅜	10 to 10½	10 to 10⅞	10½ to 11
Lard ....cental.	8 60 to 8 65	9 45 to 9 50	10 00 to 10 10	10 50 to 10 55	11 15 to 11 30
Butter:					
Creamery...........lb.	30 to 33	30 to 34	30 to 34	30 to 30	22 to 27
Good to choice dairy, pound	21 to 28	13 to 25	18 to 26	22 to 27	13 to 23
Cheese:					
Full cream...........lb.	9 to 12½	13 to 13½	12½ to 13½	13 to 14	13 to 14
Lower grades........do.	3 to 9	4 to 10½	4 to 11½	4 to 11	3 to 11
Sugar, New Orleans ..do.	6½ to 9⅜	6¼ to 9⅜	....	6½ to 8	6⅞ to 8½
Wool:					
Unwashed ....lb.	21 to 34	20 to 34	21 to 33	19 to 30	13 to 27
Fleece-washed.......do.	35 to 45	35 to 45	35 to 43	33 to 40	30 to 38
Tub-washed ....do.	39 to 50	39 to 50	35 to 46	33 to 46	38 to 42

PRODUCTS FOR 1881—Continued.

June.	July.	August.	September.	October.	November.	December.
$12 50 to $14 50	$12 50 to $13 50	$12 50 to $14 00	$13 50 to $14 00	$14 00 to $15 50	$12 00 to $13 00	$12 00 to $13 00
8 50 to 9 00	9 50 to 9 75	9 50 to 9 75	10 00 to 10 25	9 25 to 9 50	9 25 to 9 50	9 50 to 9 75
15 00 to 16 75	16 00 to 17 25	17 00 to 18 00	19 00 to 20 50	20 75 to 21 25	18 00 to 18 25	17 75 to 18 50
6½ to 10	7½ to 10½	8 to 10½	8¾ to 10½	9⅝ to 14½	8½ to 14	8¾ to 13
10 to 11½	10 to 11½	12¾ to 13	12 to 14	13 to 15	13 to 14½	11½ to 13½
11½ to 12½	11½ to 12½	12 to 13½	12½ to 14	13½ to 14½	12¾ to 14	11½ to 12¾
21 to 25	21 to 24	21 to 26	26 to 33	26 to 38	26 to 38	26 to 44
16 to 20	15 to 20	17 to 20	18 to 22	24 to 28	18 to 28	20 to 30
8 to 10	10 to 11	11 to 11½	10 to 11	13 to 14	12 to 13	10 to 12
14 to 15	13 to 14	13 to 13½	13 to 14	15 to 16	16	14 to 15
3 to 8	4 to 9	5 to 11	8 to 12	9 to 13	7 to 12	7 to 11
7⅜ to 7⅝	7⅜ to 8	7⅛ to 8	7⅜ to 8⅛	8 to 8⅛	8¼ to 8⅛	6⅜ to 6⅝
7⅜ to 8	8⅛ to 8⅜	8 to 8⅛	8⅛ to 8⅛	8⅛ to 8⅜	8⅜ to 8⅞	7 to 7⅜
9 to 9⅜	9 to 10	9 to 10	9¼ to 10	9¼ to 9⅝	9 to 9¼	7⅜ to 8⅝
6⅜ to 6⅛	6¾ to 6⅞	6⅞ to 7⅛	6⅛ to 6⅝	7⅛ to 7⅞	8 to 8¼	8¼ to 8⅛
7⅝ to 8⅝	7⅜ to 8⅞	8 to 10⅛	7⅝ to 9¾	8⅝ to 10½	9⅛ to 10⅛	9¼ to 10⅜
9⅛ to 11½	9⅝ to 11⅜	10⅞ to 12½	10½ to 11⅛	10⅜ to 11⅝	10⅜ to 11⅞	11¼ to 12
11⅞ to 12⅜	12 to 12⅜	12¾ to 13	12 to 12½	12 to 12⅛	12⅛ to 12¼	12⅜ to 12⅝
4⅛ to 4⅜	4⅛ to 4⅜	4⅛ to 6½	5⅛ to 7⅜	7 to 8⅛	6 to 7⅞	6 to 7⅝
5½ to 7	5½ to 7	6⅛ to 7⅛	7⅜ to 8⅛	9 to 12	8 to 9⅛	8 to 9⅛
20 to 22	26 to 28	25 to 26	22 to 23	25 to 26	22 to 23	22 to 23
22 to 24	29 to 30	26 to 28	25 to 26	27 to 28	25 to 26	25 to 30
11 to 12	12 to 15	15 to 17	9 to 12	12 to 13	9 to 12	9 to 13
4 to 6	4 to 5⅛	4½ to 6	4½ to 6	6 to 8	6 to 8⅛	6¼ to 7⅛
3⅛ to 5⅝	2⅛ to 5½	3 to 5⅛	3¾ to 5⅞	5 to 6½	4⅛ to 6½	4⅛ to 6⅝
5⅜ to 6	5½ to 6	5⅛ to 6½	6 to 6⅛	6⅞ to 7⅛	6⅛ to 7	6⅛ to 7
5 50 to 6 25	5 50 to 6 25	5 75 to 6 75	6 00 to 7 50	7 00 to 8 50	7 00 to 8 00	6 20 to 7 50
4 00 to 4 50	4 00 to 5 00	4 75 to 5 50	5 00 to 6 25	6 50 to 7 50	6 50 to 7 25	5 00 to 6 75
2 50 to 4 00	2 75 to 4 25	3 00 to 4 25	4 00 to 5 00	4 50 to 6 00	4 00 to 5 50	3 75 to 4 50
96 to 1 10	1 04 to 1 12	1 05 to 1 25	1 15 to 1 24	1 27 to 1 40	1 25 to 1 32	1 15 to 1 28
1 05 to 1 08	1 09 to 1 12	1 13 to 1 14	1 20 to 1 31	1 27 to 1 42	1 40 to 1 45	1 33 to 1 42
81 to 87	85 to 1 00	51 to 68	72 to 1 02	91 to 1 11	80 to 1 06	93 to 1 06
38 to 41	45 to 46	49 to 57	59 to 67	68 to 74	53 to 68	52 to 61
33 to 36	33 to 40	34 to 39	37 to 40	45 to 46	41 to 46	41 to 45
1 10 to 1 15	96 to 97	88 to 90	1 00 to 1 03	1 10 to 1 11	1 01 to 1 03	96 to 1 00
50 to 80	1 15 to 1 30	75 to 90	75 to 80	80 to 90	85 to 1 00	95 to 1 05
13 00 to 14 50	10 00 to 11 60	10 00 to 13 00	11 00 to 14 50	14 50 to 17 50	15 00 to 18 00	13 00 to 15 50
8 00 to 11 00	5 00 to 8 00	6 00 to 12 00	6 00 to 13 00	9 00 to 14 00	9 00 to 14 00	9 00 to 13 00
10 25 to 10 50	10 25 to 10 50	10 25 to 10 50	9 75 to 10 00	9 75 to 10 00	9 75 to 10 00	9 75 to 10 00
11 25 to 11 50	11 25 to 11 50	11 25 to 11 50	10 75 to 11 00	10 00 to 10 50	10 50 to 11 00	10 50 to 11 00
22 00 to 23 00	21 00 to 22 00	21 00 to 22 00	21 00 to 22 00	19 00 to 20 00	17 50 to 18 00	20 50 to 21 50
16 40 to 16 45	16 30 to 16 35	17 50 to 17 85	17 80 to 18 05	18 90 to 19 00	16 35 to 16 50	16 60 to 17 25
6 to 9½	6 to 9½	7½ to 10½	7½ to 11	8 to 11⅜	8 to 10⅛	7⅛ to 10½
10 to 10⅛	10 to 10⅜	11⅛ to 12	11⅛ to 12	12 to 13	13 to 14	11⅛ to 12⅜
10 60 to 10 80	11 30 to 11 40	11 30 to 11 35	11 30 to 11 40	12 10 to 12 15	11 37 to 11 40	11 20 to 11 40
18 to 21	18 to 22	21 to 26	26 to 30	28 to 34	30 to 36	34 to 41
14 to 18	14 to 18	16 to 22	20 to 25	22 to 29	23 to 31	25 to 35
8½ to 9	8¼ to 9	8½ to 10	10½ to 11½	12½ to 13½	11¾ to 13	10 to 12⅜
3 to 6½	2 to 6½	3 to 9	4 to 10	4 to 12	3 to 11½	5 to 11
7⅞ to 8½	7½ to 8⅜	7⅛ to 8⅜	7⅛ to 8⅜	7⅜ to 8¼	7½ to 8⅛	7 to 8
16 to 24	16 to 24	16 to 24	16 to 22	16 to 28	16 to 28	20 to [illegible]
30 to 34	30 to 34	30 to 34	30 to 34	30 to 39	30 to 30	30 to 40
36 to 38	30 to 38	30 to 38	30 to 38	30 to 42	30 to 42	30 to 44

MARKET PRICES OF FARM

Product.	January.	February.	March.	April.	May.
SAINT LOUIS.					
Flour:					
Fine and superfine . bbl.	$2 50 to $3 15	$2 50 to $3 00	$2 50 to $3 00	$2 80 to $3 20	$2 70 to $3 20
X, XX, and XXX . . do . .	3 25 to 4 40	3 15 to 4 40	3 15 to 4 85	3 25 to 4 50	3 35 to 4 55
Family and fancy . . do . .	4 60 to 5 50	4 60 to 5 50	4 70 to 5 50	4 70 to 5 40	4 70 to 5 50
Wheat:					
Winter . . . . bush.	90 to 99	89¾ to 1 01¼	90½ to 1 01	93 to 1 04	97 to 1 07
Spring . . . . do . .	. . . .	. . . .	. . . .	. . . .	. . . .
Corn . . . . do . .	34 to 38	37 to 40	37 to 42	38 to 42	38 to 47
Rye . . . . do . .	80 to 84	84 to 87	90 to 96	1 00 to 1 04	1 05 to 1 15
Barley . . . . do . .	77	72 to 80	90 to 1 10	89 to 95	96 to 1 00
Oats . . . . do . .	29 to 33	31 to 32½	32 to 33	35 to 36	34 to 36
Potatoes . . . . do . .	30 to 85	70 to 90	70 to 95	65 to 95	70 to 1 65
Hay:					
Timothy . . . . ton.	16 00 to 17 50	14 50 to 16 50	14 50 to 16 00	16 50 to 17 60	18 00 to 22 00
Prairie . . . . do . .	10 50 to 11 00	10 50 to 11 00	10 00 to 10 50	11 00 to 12 25	11 00 to 13 00
Pork:					
Mess . . . . bbl.	12 25 to 12 50	14 50 to 14 75	14 50 to 15 00	15 75 to 16 00	17 75 to 18 25
Bacon . . . . cental.	5 50 to 7 60	5 25 to 8 15	5 40 to 8 60	5 60 to 8 60	6 75 to 9 50
Hams . . . . do . .	9 50 to 10 50	9 75 to 10 75	10 50 to 11 50	10 50 to 11 00	11 00 to 13 00
Lard . . . . do . .	7 85 to 8 40	9 00 to 10 00	9 85 to 10 25	10 85 to 11 00	11 85 to 12 00
Beef:					
Mess . . . . bbl.	12 25 to 12 50	12 50 to 12 60	12 50 to 12 60	12 25 to 12 50	12 00 to 12 50
Hams . . . . lb.	9 to 10	10 to 10½	11½ to 12½	12½ to 14	12 to 14
Butter:					
Creamery . . . . lb.	29 to 32	32 to 33	30 to 34	32 to 35	25 to 26
Fair to choice . . . . . . do.	20 to 25	18 to 26	18 to 26	17 to 28	14 to 23
Cheese:					
Full cream factory . . lb.	14 to 15	14 to 15	12 to 13	15 to 16	15 to 16
Lower grades . . . . do.	11 to 12	10 to 11	9 to 11	11 to 12	11 to 12
Tobacco:					
Common to medium leaf . . . . lb.	Nominal.	Nominal.	4½ to 7½	4 to 6	4 to 5¾
Lugs . . . . do.	Nominal.	Nominal.	3½ to 5	3½ to 6½	3½ to 6¼
Wool:					
Unwashed . . . . lb.	17 to 29	15 to 27	15 to 26	20 to 23	18 to 23
Fleece-washed . . . . . do.	32 to 34	31 to 33	30 to 32	27 to 30	23 to 27
Tub-washed . . . . do.	37 to 42	30 to 42	31 to 39	39 to 42	28 to 35
Peanuts . . . . do.	2 to 3	2¾ to 4	2 to 4½	2½ to 4	2 to 3½
Sugar, New Orleans, common to choice . lb.	7 to 8	. . . .	7 to 8½	7 to 8	7½ to 8½
Cotton:					
Ordinary to good ordinary . . . . lb.	8½ to 10	8¾ to 9¾	8½ to 9½	7 to 8¾	7 to 9
Low middling to good middling . . . . lb.	10⅝ to 12¼	10⅝ to 12	10⅜ to 12	9⅝ to 11½	10¼ to 13

LIVE-STOCK

Product.	January.	February.	March.	April.	May.
NEW YORK.					
Cattle:					
Extra beeves . . . cental.	$11 00 to $12 00	$11 50 to $12 00	$10 75 to $11 50	$11 75 to $12 00	$10 75 to $11 00
Good to fair . . . . do . .	10 00 to 11 00	11 25 to 11 50	9 75 to 10 25	10 50 to 11 50	9 75 to 10 50
Poor to common . . . do . .	3 50 to 8 75	5 00 to 9 00	8 50 to 9 00	9 75 to 10 25	9 00 to 10 00
Milch cows . . . . head.	30 00 to 55 00	30 00 to 55 00	30 00 to 55 00	30 00 to 55 00	30 00 to 60 00
Veal calves . . . . . cental.	5 50 to 7 50	6 00 to 9 00	6 25 to 9 00	5 00 to 8 00	4 50 to 6 50
Sheep . . . . do . .	4 50 to 6 50	4 35 to 6 35	5 50 to 7 00	5 50 to 7 00	5 00 to 7 75
Swine . . . . do . .	4 75 to 5 00	5 75 to 6 25	5 70 to 6 20	6 00 to 6 30	6 10 to 6 50
CINCINNATI.					
Cattle:					
Choice to extra shipping steers . . . . cental.	5 00 to 5 75	4 60 to 5 25	4 75 to 5 25	4 75 to 5 25	5 00 to 5 50
Fair to good shipping steers . . . . cental.	4 25 to 4 75	4 00 to 4 50	4 00 to 4 50	4 00 to 4 50	4 50 to 4 90
Good to choice butchers' grades . . . . cental.	4 00 to 4 60	4 15 to 4 75	4 25 to 4 90	4 50 to 5 25	4 50 to 5 40
Fair to medium butchers' grades . . . . cental.	3 15 to 3 85	3 25 to 4 00	3 25 to 4 00	3 50 to 4 25	3 50 to 4 25
Common butchers' grades . . . . cental.	2 25 to 3 00	2 50 to 3 00	2 25 to 3 00	2 25 to 3 25	2 25 to 3 25
Oxen, cows, and heifers . . . . cental.	3 00 to 4 40	3 00 to 4 65	3 25 to 4 75	3 25 to 5 00	3 25 to 5 15
Sheep . . . . do . .	3 00 to 5 50	3 00 to 5 50	3 00 to 5 50	3 25 to 5 25	3 50 to 4 75
Swine . . . . do . .	3 90 to 5 00	4 25 to 5 85	4 50 to 6 25	4 25 to 6 25	4 50 to 6 40

PRODUCTS FOR 1881—Continued.

June.	July.	August.	September.	October.	November.	December.
$2 75 to $3 35	$3 10 to $3 65	$3 00 to $3 65	$4 50 to $5 25	$4 60 to $5 85	$4 35 to $5 00	$4 25 to $4 75
3 45 to 4 60	3 90 to 5 05	3 90 to 5 05	5 40 to 6 50	5 60 to 6 70	5 20 to 6 25	4 90 to 5 75
4 90 to 5 85	5 35 to 6 35	5 65 to 6 60	6 65 to 7 50	6 90 to 7 70	6 35 to 7 25	6 10 to 7 10
1 02 to 1 14	1 05 to 1 15½	1 06 to 1 19	1 28 to 1 43	1 28 to 1 46	1 20 to 1 37	1 19 to 1 35
....	....	....	....	....	....	....
47 to 55	37 to 48	49 to 52	57 to 77	66 to 75	60 to 71	59 to 68
1 10 to 1 15	60 to 80	84 to 85	1 07 to 1 11	1 09 to 1 18	1 00 to 1 03	92 to 99
Nominal.	Nominal.	Nominal.	1 06 to 1 07	95 to 1 15	1 05 to 1 15	85 to 1 01
35 to 37	33 to 34	30 to 44	39 to 42	43 to 46	41 to 45	46 to 48
70 to 1 05	80 to 1 00	70 to 80	85 to 1 03	90 to 1 12	1 10 to 1 15	1 00 to 1 17
15 00 to 16 00	12 00 to 14 00	12 00 to 15 00	15 00 to 17 00	16 00 to 18 00	20 00 to 23 00	19 50 to 21 50
10 00 to 10 50	9 00 to 10 50	8 50 to 8 75	10 00 to 12 00	9 50 to 12 50	12 00 to 15 00	13 50 to 15 00
16 25 to 17 25	16 25 to 16 75	18 30 to 19 00	18 25 to 19 25	19 50 to 20 25	17 75 to 18 50	16 90 to 17 25
6 50 to 9 30	7 00 to 9 75	7 40 to 10 50	8 75 to 11 35	9 50 to 12 00	8 75 to 10 75	8 65 to 10 45
11 00 to 13 00	11 00 to 13 00	12 00 to 14 00	14 00 to 15 00	15 00 to 16 00	14 00 to 15 00	13 00 to 14 00
10 50 to 11 25	11 30 to 11 50	11 75 to 12 25	11 15 to 12 10	12 05 to 13 00	11 50 to 13 00	11 00 to 12 25
12 00 to 12 50	12 00 to 12 50	....	....	12 50	12 50	12 50 to 13 00
13 to 14	13 to 14	....	....	14½ to 15	12 to 14	11½ to 13
20 to 25	20 to 23	22 to 24	26 to 31	30 to 34	33 to 36	36 to 40
15 to 18	14 to 17	16 to 20	18 to 24	19 to 28	23 to 32	24 to 35
14 to 15	13 to 14	13 to 14	....	....	....	13 to 15
10 to 11	9 to 10	9 to 10	....	....	....	11 to 12
4 to 5½	Nominal.	Nominal.	Nominal.	Nominal.	....	5½ to 7½
3½ to 6½	3½ to 7	Nominal.	Nominal.	Nominal.	....	4½ to 7½
18 to 25	18 to 24	13 to 23	18 to 25	18 to 25	18 to 25	18 to 25
22 to 28	22 to 27	17 to 25	18 to 26	....	....	....
28 to 38	31 to 40	30 to 39	30 to 39	31 to 41	30 to 39	30 to 38
2 to 3½	2½ to 4	2 to 4	2 to 4	6 to 8	4 to 8	4 to 5
7½ to 8½	7½ to 8½	8 to 9	....	....	....	8½ to 8¾
7½ to 8½	7½ to 8½	8 to 9½	8 to 9½	8½ to 9½	8½ to 10½	9½ to 10½
9½ to 11	9½ to 11¼	10½ to 11½	10½ to 11½	10¾ to 11½	10½ to 11½	11½ to 11⅝

MARKETS.

$11 50 to $12 00	$11 25 to $12 00	$12 00 to $12 50	$12 00 to $12 50	$11 50 to $12 25	$11 75 to $12 25	$11 25 to $12 00
10 50 to 11 00	10 50 to 11 00	10 75 to 11 25	11 00 to 11 50	10 00 to 11 00	9 00 to 11 50	9 25 to 11 00
9 00 to 10 50	8 75 to 10 50	9 25 to 10 75	8 00 to 10 00	7 00 to 10 00	7 00 to 8 25	7 25 to 9 00
30 00 to 60 00	40 00 to 50 00	30 00 to 55 00	30 00 to 60 00	40 00 to 60 00	55 00 to 65 00	35 00 to 60 00
5 00 to 6 75	5 50 to 7 75	5 00 to 7 75	5 00 to 8 50	5 00 to 8 50	5 50 to 9 50	4 75 to 9 50
4 50 to 6 25	3 50 to 7 25	3 50 to 7 25	3 75 to 6 40	4 00 to 6 75	3 25 to 5 25	3 25 to 5 25
6 00 to 6 30	6 00 to 6 40	7 10 to 7 20	6 80 to 6 90	6 50 to 6 75	5 50 to 6 50	5 50 to 6 25
5 40 to 5 75	5 40 to 5 75	5 50 to 5 75	5 25 to 5 75	5 75 to 6 00	5 50 to 6 00	5 25 to 6 00
4 90 to 5 25	5 00 to 5 25	4 75 to 5 25	4 50 to 5 00	4 50 to 5 50	4 50 to 5 25	4 25 to 5 00
4 65 to 5 50	4 50 to 5 25	4 75 to 5 00	4 00 to 4 50	4 25 to 4 75	4 00 to 4 50	4 00 to 4 50
3 65 to 4 50	3 25 to 4 00	3 00 to 3 75	3 00 to 3 75	3 25 to 4 00	3 00 to 3 75	3 00 to 3 75
2 50 to 3 50	2 25 to 3 00	2 00 to 2 50	1 50 to 2 25	2 00 to 2 50	2 00 to 2 75	1 75 to 2 50
3 75 to 5 40	3 50 to 5 00	3 50 to 4 75	3 25 to 4 50	3 25 to 4 50	3 25 to 4 25	3 25 to 4 00
2 50 to 4 75	2 40 to 4 50	2 50 to 5 25	2 50 to 4 75	2 75 to 5 00	2 50 to 4 25	2 25 to 4 50
4 25 to 6 10	4 50 to 6 25	5 25 to 7 00	4 90 to 7 00	5 25 to 7 75	4 50 to 6 40	5 00 to 6 40

LIVE-STOCK

Products.	January.	February.	March.	April.	May.
CHICAGO.					
Cattle:					
Extra beeves ...cental.	$5 75 to $6 25	$5 75 to $6 00	$5 75 to $6 60	$5 85 to $6 35	$5 80 to $6 00
Choice beeves .....do..	4 85 to 5 40	5 00 to 5 50	5 25 to 5 50	5 60 to 5 75	5 50 to 5 75
Good to medium grades, cental................	3 75 to 4 65	4 00 to 4 85	4 25 to 5 00	4 60 to 5 50	4 80 to 5 40
Poor to common grades, cental................	2 50 to 3 50	2 60 to 3 85	2 75 to 4 25	3 25 to 4 50	3 50 to 4 75
Veal calves .....cental.	3 50 to 5 75	3 50 to 5 75	3 50 to 5 75	3 75 to 6 25	3 50 to 6 50
Sheep...............do..	3 50 to 5 50	3 50 to 5 50	3 75 to 5 50	4 00 to 6 00	4 75 to 6 00
Swine ....do..	3 70 to 5 25	4 25 to 6 30	5 15 to 6 60	4 50 to 6 40	5 00 to 6 40
SAINT LOUIS.					
Cattle:					
Choice natives..cental.	5 25 to 5 75	5 25 to 5 60	5 35 to 5 60	5 40 to 5 75	5 50 to 6 15
Fair to prime......do..	4 25 to 5 20	4 25 to 5 20	4 25 to 5 20	4 50 to 5 30	4 75 to 5 50
Fair to good butchers' steers.........cental.	3 65 to 4 25	3 65 to 4 25	3 65 to 4 25	3 75 to 4 50	4 00 to 4 70
Common to good stock steers ....cental.	2 25 to 2 90	2 25 to 3 15	2 50 to 3 75	3 00 to 3 75	3 00 to 3 75
Oxen ....do..	3 00 to 3 40	3 00 to 3 40	3 00 to 4 00	3 00 to 4 00	3 00 to 4 00
Cows and heifers..do..	2 00 to 3 50	2 00 to 3 25	3 00 to 4 00	3 00 to 3 50	3 50 to 4 25
Milch cows ......head.	15 00 to 45 00	20 00 to 45 00	20 00 to 45 00	20 00 to 45 00	20 00 to 45 00
Calves ....do..	5 00 to 10 00	5 00 to 10 00	5 00 to 10 00	5 00 to 10 00	5 00 to 10 00
Sheep ....cental.	2 25 to 5 50	2 25 to 5 50	2 25 to 5 50	2 50 to 6 00	3 25 to 6 65
Swine ....do..	3 50 to 4 80	5 10 to 5 60	5 15 to 6 15	5 50 to 6 15	5 80 to 6 15
Horses:					
Good plugs ......head.	20 00 to 40 00	25 00 to 40 00	25 00 to 35 00	25 00 to 40 00	50 00 to 80 00
Southern ....do..	75 00 to 110 00	55 00 to 85 00	65 00 to 100 00	50 00 to 85 00	90 00 to 116 00
Streeters...........do..	75 00 to 110 00	75 00 to 110 00	80 00 to 115 00	90 00 to 130 00	80 00 to 120 00
Fancy driving.....do..	90 00 to 170 00	90 00 to 170 00	100 00 to 170 00	100 00 to 170 00	100 00 to 200 00
Heavy draft.......do..	130 00 to 175 00	130 00 to 175 00	130 00 to 175 00	130 00 to 175 00	85 00 to 200 00
Mules:					
14 hands high .....do..	75 00 to 80 00	80 00 to 85 00	80 00 to 85 00	70 00 to 75 00	100 00 to 111 00
14½ hands high ....do..	90 00 to 100 00	90 00 to 95 00	90 00 to 100 00	100 00 to 110 00	110 00 to 125 00
15 hands high .....do..	100 00 to 110 00	100 00 to 110 00	105 00 to 112 00	110 00 to 120 00	120 00 to 130 00
15½ hands high ....do..	125 00 to 150 00	125 00 to 150 00	115 00 to 150 00	120 00 to 140 00	130 00 to 140 00
16 hands high .....do..	150 00 to 175 00	155 00 to 165 00	155 00 to 175 00	150 00 to 175 00	150 00 to 185 00
NEW ORLEANS.					
Cattle:					
Corn-fed beeves.cental.	3 50 to 4 50	3 50 to 4 50	2 50 to 5 50	2 50 to 5 00	2 50 to 5 50
Grass-fed beeves .head.	10 00 to 30 00	10 00 to 30 00	10 00 to 25 00	10 00 to 25 00	10 00 to 25 00
Milch cows.........do..	25 00 to 85 00	25 00 to 75 00	25 00 to 75 00	25 00 to 75 00	25 00 to 75 00
Calves ....do..	6 00 to 10 00	6 00 to 10 00	6 00 to 9 00	6 50 to 10 00	6 50 to 10 00
Sheep ....do..	2 00 to 3 50	2 00 to 4 00	2 00 to 5 00	2 00 to 5 00	2 00 to 5 00
Swine ....cental.	2 50 to 4 50	2 50 to 4 25	3 00 to 5 50	3 00 to 5 25	3 00 to 5 50
Horses:					
Common plug....head.	60 00 to 110 00	60 00 to 110 00	60 00 to 110 00	60 00 to 100 00	50 00 to 90 00
Good work ....do..	110 00 to 150 00	110 00 to 150 00	110 00 to 150 00	90 00 to 145 00	90 00 to 140 00
Saddle and harness.do..	150 00 to 200 00	150 00 to 200 00	150 00 to 200 00	150 00 to 190 00	140 00 to 175 00
Mules:					
Small and common.do..	75 00 to 125 00	75 00 to 125 00	75 00 to 125 00	65 00 to 110 00	65 00 to 110 00
Good medium .....do..	150 00 to 180 00	150 00 to 180 00	150 00 to 180 00	125 00 to 150 00	140 00 to 155 00
Rice culture.......do..	120 00 to 160 00	120 00 to 160 00	120 00 to 160 00	100 00 to 140 00	110 00 to 140 00
First-class ....do..	175 00 to 220 00	175 00 to 220 00	175 00 to 220 00	150 00 to 190 00	150 00 to 180 00
Coal, cart, and heavy city use........head.	210 00 to 240 00	210 00 to 240 00	210 00 to 240 00	190 00 to 225 00	185 00 to 200 00

MARKETS—Continued.

June.	July.	August.	September.	October.	November.	December.
$6 00 to $6 20	$6 00 to $6 25	$6 00 to $6 35	$6 00 to $6 35	$6 40 to $6 75	$6 50 to $6 80	$6 50 to $6 80
5 75 to 5 95	5 75 to 5 85	5 70 to 5 80	5 25 to 5 50	5 80 to 6 15	6 00 to 6 80	5 65 to 6 10
5 15 to 5 70	4 90 to 5 65	4 75 to 5 75	4 00 to 4 75	3 75 to 5 50	4 00 to 5 75	4 25 to 5 50
3 50 to 5 00	3 25 to 4 50	3 00 to 4 00	3 00 to 3 50	2 75 to 3 50	2 75 to 4 00	2 75 to 3 85
4 25 to 7 00	3 50 to 7 00	3 50 to 7 00	3 50 to 6 50	4 00 to 6 50	4 00 to 7 00	4 00 to 7 00
5 00 to 6 00	3 00 to 5 25	3 00 to 4 75	3 00 to 4 50	3 25 to 4 25	3 00 to 5 00	2 50 to 5 15
5 00 to 6 15	4 50 to 6 25	5 00 to 6 85	6 00 to 7 00	6 25 to 7 00	4 50 to 6 90	5 60 to 6 50
6 10 to 6 30	6 00 to 6 25	6 00 to 6 25	6 15 to 6 45	6 25 to 6 75	6 25 to 7 00	6 25 to 6 50
5 00 to 6 00	5 00 to 5 90	5 00 to 5 90	4 75 to 6 10	4 75 to 6 15	4 75 to 6 15	4 75 to 6 15
4 90 to 5 25	4 75 to 5 15	4 75 to 5 15	3 75 to 4 25	3 85 to 4 50	4 00 to 4 75	4 00 to 4 75
3 00 to 4 75	3 00 to 3 75	3 00 to 3 75	2 00 to 3 50	2 00 to 3 50	2 00 to 3 50	2 00 to 2 75
3 00 to 4 00	3 00 to 4 00	3 00 to 4 00	3 00 to 4 00	3 00 to 4 00	3 00 to 4 00	2 00 to 4 00
2 50 to 3 25	2 50 to 3 25	2 00 to 4 00	2 00 to 3 25	2 00 to 4 00	2 00 to 4 00	2 00 to 4 00
20 00 to 45 00	18 00 to 42 00	18 00 to 40 00	15 00 to 35 00	15 00 to 40 00	16 00 to 47 00	20 00 to 55 00
4 00 to 8 00	4 00 to 8 00	5 00 to 10 00	5 00 to 10 00	5 00 to 10 00	5 00 to 10 00	5 00 to 10 00
2 75 to 4 50	2 75 to 4 50	2 75 to 4 50	2 25 to 4 00	2 25 to 4 25	2 25 to 4 25	3 00 to 5 00
5 45 to 6 15	5 70 to 6 20	6 00 to 7 00	6 25 to 7 00	6 20 to 7 25	5 00 to 6 50	5 00 to 6 50
30 00 to 60 00	30 00 to 60 00	30 00 to 50 00	50 00 to 60 00	30 00 to 40 00	35 00 to 45 00	30 00 to 50 00
60 00 to 125 00	50 00 to 90 00	50 00 to 100 00	70 00 to 90 00	60 00 to 85 00	60 00 to 80 00	55 00 to 85 00
100 00 to 135 00	80 00 to 120 00	80 00 to 120 00	75 00 to 110 00	95 00 to 125 00	90 00 to 120 00	85 00 to 115 00
110 00 to 200 00	90 00 to 200 00	90 00 to 140 00	80 00 to 150 00	85 00 to 160 00	80 00 to 140 00	100 00 to 175 00
100 00 to 275 00	125 00 to 200 00	115 00 to 200 00	115 00 to 175 00	120 00 to 200 00	110 00 to 180 00	80 00 to 200 00
100 00 to 120 00	90 00 to 100 00	90 00 to 100 00	90 00 to 100 00	80 00 to 85 00	80 00 to 85 00	75 00 to 80 00
110 00 to 125 00	110 00 to 125 00	110 00 to 125 00	100 00 to 110 00	90 00 to 100 00	90 00 to 105 00	90 00 to 100 00
120 00 to 130 00	125 00 to 135 00	125 00 to 135 00	110 00 to 120 00	100 00 to 115 00	110 00 to 120 00	110 00 to 115 00
135 00 to 150 00	140 00 to 150 00	145 00 to 155 00	120 00 to 160 00	115 00 to 150 00	125 00 to 150 00	125 00 to 140 00
150 00 to 190 00	130 00 to 200 00	130 00 to 200 00	110 00 to 225 00	160 00 to 200 00	110 00 to 200 00	160 00 to 200 00
10 00 to 35 00	10 00 to 35 00	11 00 to 35 00	7 00 to 38 00	7 00 to 38 00	8 00 to 40 00	7 00 to 35 00
25 00 to 75 00	25 00 to 75 00	25 00 to 75 00	25 00 to 75 00	25 00 to 75 00	25 00 to 80 00	25 00 to 80 00
5 00 to 9 00	6 00 to 10 00	6 50 to 10 00	5 00 to 9 00	5 00 to 9 00	6 00 to 10 00	5 00 to 9 00
2 00 to 5 00	1 50 to 4 00	1 50 to 4 00	1 50 to 3 00	1 50 to 3 50	1 50 to 3 00	1 50 to 3 00
3 00 to 6 00	3 50 to 5 50	3 50 to 6 50	3 50 to 6 00	3 50 to 6 00	3 50 to 7 00	5 00 to 7 00
60 00 to 90 00	60 00 to 90 00	60 00 to 90 00	70 00 to 110 00	70 00 to 110 00	70 00 to 110 00	70 00 to 110 00
100 00 to 145 00	100 00 to 145 00	100 00 to 145 00	110 00 to 150 00	110 00 to 150 00	110 00 to 150 00	110 00 to 150 00
150 00 to 175 00	150 00 to 175 00	150 00 to 175 00	150 00 to 200 00	150 00 to 200 00	150 00 to 200 00	150 00 to 200 00
60 00 to 100 00	60 00 to 100 00	60 00 to 100 00	80 00 to 125 00	80 00 to 125 00	80 00 to 125 00	80 00 to 125 00
130 00 to 150 00	130 00 to 150 00	130 00 to 150 00	150 00 to 175 00	150 00 to 175 00	150 00 to 175 00	150 00 to 175 00
100 00 to 130 00	100 00 to 130 00	100 00 to 130 00	125 00 to 150 00	125 00 to 150 00	125 00 to 150 00	125 00 to 150 00
150 00 to 175 00	150 00 to 175 00	150 00 to 175 00	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00
175 00 to 200 00	175 00 to 200 00	175 00 to 200 00	225 00 to 250 00	225 00 to 250 00	225 00 to 250 00	225 00 to 250 00

RAILROAD BUILDING.

The construction of railroads has rendered possible the rapid settlement of the great interior areas of fertile lands which must have remained comparatively uncultivated but for facilities afforded for reaching the markets of the world.

A half century ago, in 1831, there were 72 miles of railroads built in addition to the 23 miles previously in operation. In the following ten years, to the end of 1841, there were built 3,420 miles; in ten years from 1842 to 1851 more than twice as much, or 7,447 miles. From 1852 to 1861, inclusive, a great impetus was given to railroad building, coincident with the general industrial progress of the country, and 20,304 miles were added to the completed mileage of railroads.

A lower rate of progress obtained during the war period, yet by the end of another decade 28,997 miles were added; and in the ten years, including 1881, the immense advance of 44,503 miles was contributed to the mileage of operative roads.

Mr. Henry N. Poor, the authority in railroad statistics, makes the aggregate mileage at the close of 1881 104,813 miles, of which more than a tenth is the work of the past year.

The work is now being rapidly pushed, increasing the magnitude of these figures. The following are the authorized figures illustrating this progress, which is also represented geographically in the diagram:

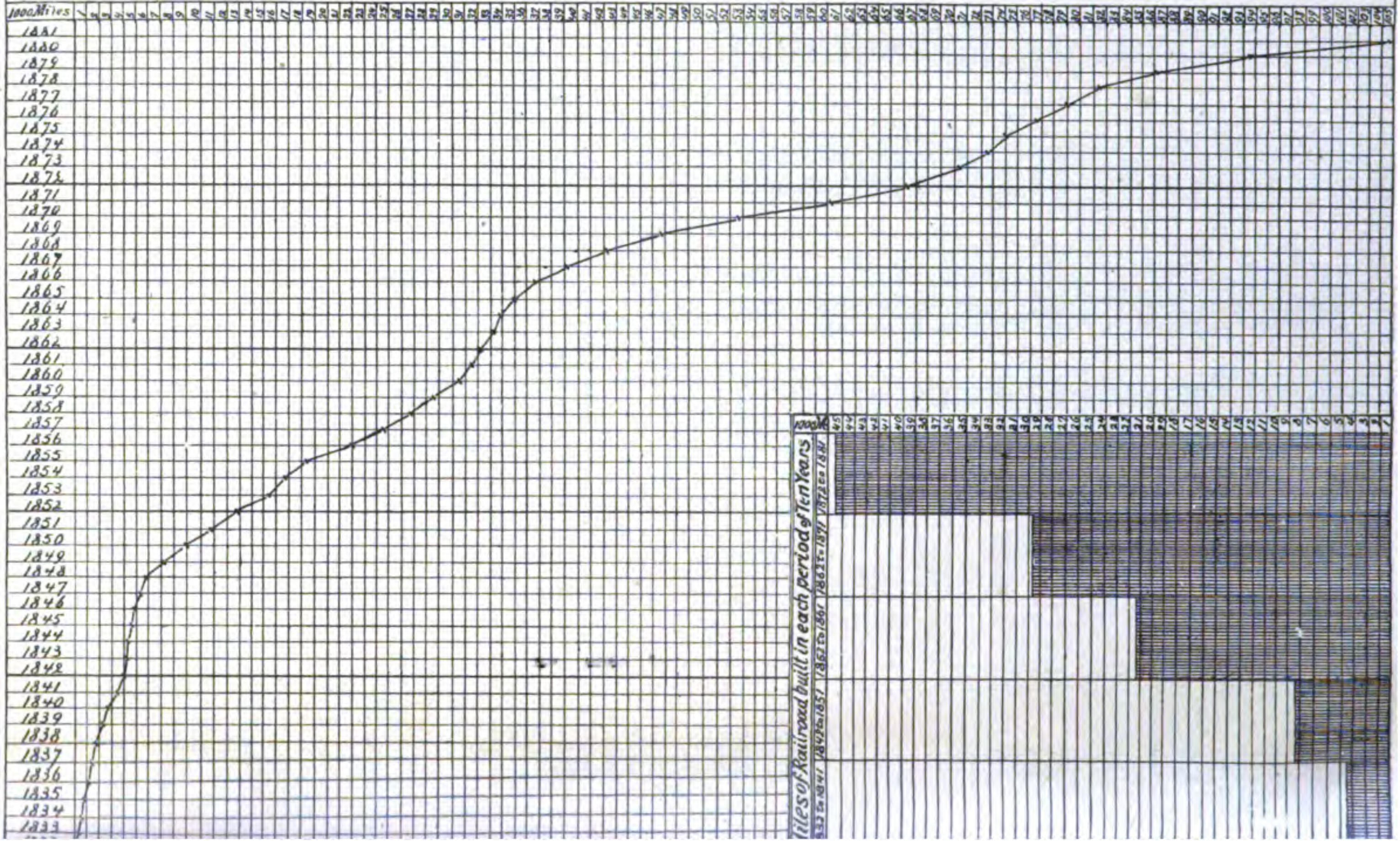
Year.	Miles in operation.	Annual increase of mileage.	Year.	Miles in operation.	Annual increase of mileage.	Year.	Miles in operation.	Annual increase of mileage.	Year.	Miles in operation.	Annual increase of mileage.
1830....	23	....	1843...	4,185	159	1856...	22,016	3,647	1869...	46,844	4,615
1831....	95	72	1844...	4,377	192	1857...	24,503	2,647	1870...	52,914	6,070
1832....	229	134	1845...	4,633	256	1858...	26,968	2,465	1871...	60,293	7,379
1833....	380	151	1846...	4,930	297	1859...	28,789	1,821	1872...	66,171	5,878
1834....	633	253	1847...	5,598	668	1860...	30,635	1,846	1873...	70,278	4,107
1835....	1,098	465	1848...	5,996	398	1861...	31,286	651	1874...	72,383	2,105
1836....	1,273	175	1849...	7,365	1,369	1862...	32,120	834	1875...	74,096	1,712
1837....	1,497	224	1850...	9,021	1,656	1863...	33,170	1,050	1876...	76,808	2,712
1838....	1,913	416	1851...	10,982	1,961	1864...	33,908	738	1877...	79,089	2,281
1839....	2,302	389	1852...	12,908	1,926	1865...	35,085	1,177	1878...	81,776	2,687
1840....	2,818	516	1853...	15,360	2,452	1866...	36,801	1,742	1879...	86,497	4,721
1841....	3,535	717	1854...	16,720	1,360	1867...	39,250	2,449	1880...	93,671	7,174
1842....	4,026	491	1855...	18,374	1,654	1868...	42,229	2,979	1881...	104,813	11,142

THE NEW YORK CANAL SYSTEM.

This great work of internal improvement, which has been such a boon to the farmers of Central New York and of the West, has carried freight enough to load about half a million trains of twenty full cars each, and is now annually floating to market the equivalent of more than sixteen thousand such train loads.

A record of the movement is carefully kept and audited by a State officer, which shows the whole number of tons moved, the number carried to tide-water, the number of tons of through freight from the West to tide-water, and the number received from points in the State of New Xork. A summary of these figures, by decades, will mass the results to be grasped conveniently by the understanding, and a diagram which accompanies will present the movement of forty-four years to the eye of the reader. In studying these figures it should be remembered that the tons to tide-water from the Western States do not include all the freight that comes from the West, as a considerable and increasing portion is now distributed through the interior of New York and New

Diagram showing number of Miles in operation and built annually from 1832 to 1882 inclusive.



England. This distribution is shown by subtracting the one hundred million tons "to tide-water" from the grand aggregate of one hundred and seventy-seven millions of tons, showing that 43 per cent. of all, most of it from States west of New York, a large portion as far west as Illinois, has failed to reach tide-water.

The freight from New York State, as the figures show, is much less than between 1840 and 1860, from the increase of railroads and decrease of their freight rates. The increase by decades is as follows:

Years.	Tons moved.	Tons to tide-water.	Tons to tide-water from Western States.	Tons from New York.
1837 to 1840	5,856,066	2,523,402	419,277	1,231,031
1841 to 1850	21,972,233	12,682,475	4,824,724	5,132,582
1851 to 1860	38,439,739	21,539,453	11,865,329	4,201,303
1861 to 1870	55,185,326	31,017,912	21,501,150	2,414,972
1871 to 1880	56,290,026	32,755,956	21,980,740	2,936,514
Total	177,243,390	100,519,198	60,591,220	15,936,402

There have been annual fluctuations, due to difference in quantity of freight to be carried, and still more to the inducements offered by railroads for the heavy freight that is the staple of the canal trade; but there has been neither progressive advance or decline in quantity for twenty years. The annual table will present these fluctuations, and the prior progress of the trade:

Years.	Tons moved.	Tons to tide-water.	Tons to tide-water from Western States.	Tons from New York.
1837	1,171,296	611,781	56,225	321,252
1838	1,333,011	640,481	83,233	336,016
1839	1,435,713	602,128	121,671	264,596
1840	1,416,046	669,012	158,148	309,167
1841	1,521,661	774,334	224,176	308,844
1842	1,236,931	666,626	221,477	258,672
1843	1,513,439	836,861	256,376	378,969
1844	1,816,586	1,031,395	306,025	499,416
1845	1,977,565	1,204,943	304,551	656,039
1846	2,268,662	1,362,319	506,608	600,662
1847	2,869,810	1,744,283	812,840	618,412
1848	2,796,230	1,447,905	650,154	534,183
1849	2,894,732	1,579,946	768,659	498,068
1850	3,076,617	2,033,863	773,858	780,817
1851	2,582,733	1,977,151	966,993	541,664
1852	3,863,441	2,234,822	1,151,978	502,721
1853	4,247,853	2,505,797	1,213,690	637,748
1854	4,165,862	2,223,743	1,100,526	602,167
1855	4,022,617	1,895,593	1,092,876	327,839
1856	4,116,082	2,123,469	1,212,550	374,580
1857	3,344,061	1,617,187	919,998	197,201
1858	3,665,192	1,985,142	1,273,109	223,578
1859	3,781,684	2,121,672	1,036,634	414,699
1860	4,650,214	2,854,877	1,896,975	379,086
1861	4,507,635	2,980,144	2,158,425	291,184
1862	5,598,785	3,402,709	2,594,837	322,257
1863	5,557,692	3,274,727	2,279,252	368,437
1864	4,852,941	2,805,257	1,907,136	239,498
1865	4,729,654	2,730,181	1,903,642	174,719
1866	5,775,220	3,305,607	2,235,716	287,948
1867	5,688,325	3,029,695	2,129,405	96,707
1868	6,442,225	3,237,149	2,215,222	163,350
1869	5,859,080	3,096,142	2,028,568	229,121
1870	6,173,769	3,156,301	2,048,947	241,751
1871	6,467,888	3,495,801	2,276,393	372,484
1872	6,673,370	3,647,944	2,456,022	214,383
1873	6,364,782	3,376,649	2,527,068	58,287
1874	5,804,588	3,223,112	2,206,604	263,693
1875	4,859,958	2,608,777	1,476,238	438,704
1876	4,172,129	2,426,182	1,402,768	342,552
1877	4,955,963	2,986,812	2,010,081	287,927
1878	5,171,320	3,637,101	2,461,066	370,624
1879	5,362,372	3,286,176	2,363,218	182,784
1880	6,457,636	4,067,402	2,801,282	425,076
Total	177,243,390	100,519,198	60,591,220	15,936,402

THE DIVISION AND ITS WORK.

The province of agricultural statistics is to measure the productive resources of the nation, to survey its crop areas, to record its garnered products. It is more—to balance the production and consumption of the nations, and calculate therefrom the oscillation of prices. The relative profit of systems of culture, the profitable distribution of individual crop areas, can best be shown by statistics; questions of national economy are decided by appeal to statistical investigation; and while the plain farmer cannot afford to decline the study of statistics, the statesman finds it the most essential and the most difficult of his labors.

With a range through the entire field of rural effort, and of science applied to agriculture, the ground occupied by agricultural statistics is practically measureless and the demand for statistical service limitless. Hence the work of the division has neither cessation nor respite.

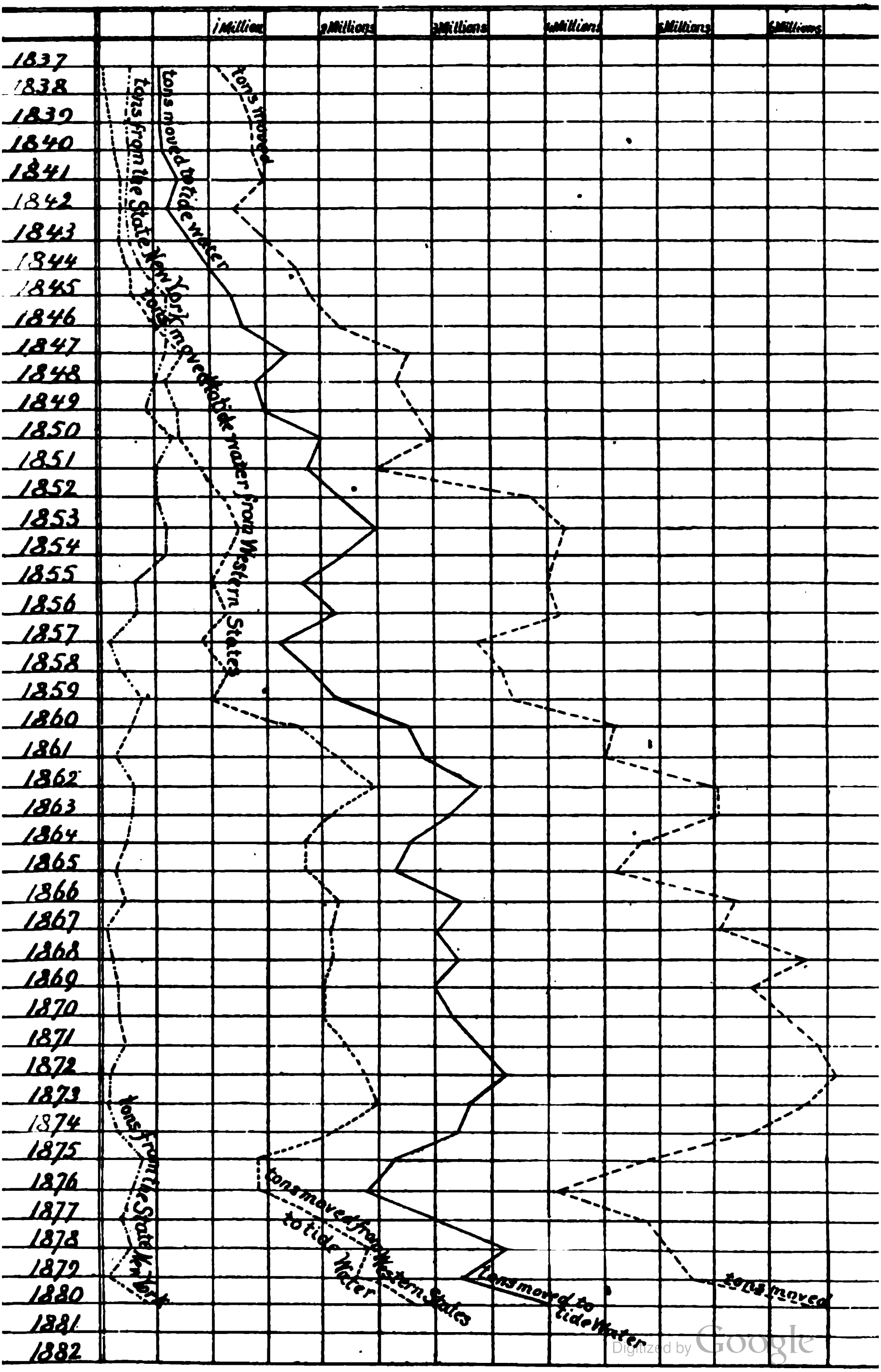
General and special statistics, domestic and foreign, national and international, are required for use of officials connected with the legislative and executive departments of the government, boards of agriculture, chambers of commerce, educational institutions, editors, and others in representative positions. Much service of this tenor is constantly performed, limited only by practical possibilities and the endurance of a small corps of clerical assistants.

The crop-reporting work of this division covers an area of nearly 200,000,000 acres of crops harvested by the hand of man, and includes in cattle industries a range of several hundred millions more. The spirit of the age demands prompt, frequent, and reasonably accurate reports of these vast interests; the unreasoning haste of greedy impulsiveness demands a minute census weekly, simultaneous in collection, and instantaneous in consolidation and distribution. The tendency of the unthinking public is to statistical pretense, inaccuracy, and looseness of statement. It will be the aim of the direction of this service to render it thorough, efficient, and reliable in results; to use systematic scientific methods; to reach practical and exact conclusions, and present them conscientiously.

To this end the Commissioner of Agriculture has obtained an increased appropriation from Congress; and among the means adopted for improvement of this service is the appointment of a statistical agent for each State and Territory, to act as head of a State corps of correspondents, as a lieutenant of the statistician in directing and executing the work of such district. Among these agents are several experienced officers of State departments or boards of agriculture, heretofore in charge of a State corps of statistical reporters upon precisely the same plan in operation in this department. Thus duplication of work is avoided, discrepancies are harmonized, results are verified, avoiding the confusion of a double series of reports, and securing greater accuracy and higher public appreciation of the value of the results. Unfortunately, there are few States that have an organization for the collection of statistics, and in the others it becomes necessary to select agents who have not been educated in statistical collection by such experience; yet there are persons possessed of judgment in agricultural affairs, capacity for organization, a taste for statistical collection, and a "genius for work," from whom to select these agents, in the expectation of developing trained and skilled assistants.

This improvement in our statistical machinery has been put in operation, and valuable results have already been secured in different

Diagram showing the aggregate numbers of tons of freight moved on the Erie canal-total tons moved to tide water-tons moved to tide water from Western States and tons from State of New-York.



directions. It is realized, however, that whatever zeal and discretion may plan and direct, there must be intelligent and permanent local correspondents—resident farmers rather than peripatetic salesmen; established land-holders, instead of transient tradesmen—otherwise the presentation of approximately accurate results will be an impossibility and an absurdity. It is believed that with the judicious assistance of these agents an efficient organization of the machinery for statistical collection may be perfected and steadily maintained, with increasing competency and higher success.

In view of the influence of foreign demand on prices, and of the great volume of exportation of certain products, notably of grain and "provisions," it has been deemed advisable, necessary even, that an effort should be made to give early information to American farmers of the prospective requirements of the foreign trade.

For this purpose an agency has been established in Europe, in charge of Mr. Edmund J. Moffat, with headquarters at London, at the office of the consul-general. He arrived there at the close of the harvest season, and has already vigorously commenced the work of organization throughout Europe, with the co-operation of officers of the State Department and our diplomatic service. Much is expected of this agency in the future in accurate reports of crop prospects, valuable statistical exchanges, and miscellaneous information of value to this department and the agriculture of the country.

A section of the division of statistics has been organized, under requirement of Congress, for the monthly publication of freight rates of transportation. The changes of rates on principal agricultural products and farmers' supplies have been given for all the through east and west trunk lines, the Pacific roads, and great north and south railway systems, and lake, river, and coast lines of steamers. Not only the through rates, but an immense array of local rates for groups of minor points in all parts of the country, have been accurately presented. Special rates for certain products sent to various points, including live stock, cotton, rice, &c., have been promptly published for the information of farmers who wish to seek the best markets and forward their products with an intelligent view of the cost of shipment.

The organization of comprehensive special work in dairy statistics has also been commenced, and other special investigations are in progress.

CROPS OF THE YEAR 1882.

In order to bring the results of work in the division of statistics up to the close of the year 1882, I respectfully present the following, as supplementary to this report, which includes the estimates of 1881, with investigations of the early months of the present season.

The organization of the corps of State statistical agents, of the European statistical agency with headquarters in the office of the consul-general at London, and the section of statistics of railroad and steamboat transportation rates, with other work for the improvement of the service of the division in other respects, are presented with sufficient fullness perhaps in the preceding pages.

The unusual diminution of production in 1881, in all cereals except oats, in potatoes, in cotton, and in nearly all products of the farm, caused an uneasy feeling during the untoward and unpromising planting season of the present year, which was generally late, cold, and wet, preventing work, rendering necessary replanting, and stiffening prices of grains and meats. The farmers, however, did not for a moment yield to despondency, but redoubled their efforts, and with the aid of improved implements accomplished more hard work than was ever done in the same period in the United States. But from June the skies were propitious, rains seasonable, and summer heat moderate and long continued, and improvement was rapid and to an unusual degree uninterrupted. There were some exceptions, notably in New England, New York, and New Jersey, where an injurious drought, extending to the highlands and mountains from the sea-coast, reduced the production of nearly all crops. Elsewhere, in the great agricultural sections, there was less loss, whether from drought, storms, floods, or insects, than for many years; and the aggregate result is a rate of yield generally above the average, in those crops which mature by midsummer, and medium production of crops requiring longer time to mature. In the South all crops were large, because the lateness of the spring was greatly modified there, and for all the cereals and vegetables the moisture and low temperature of the spring was especially favorable. The aggregate result is a year of general abundance.

CORN.

This is, next to grass, the great crop of the country, grown everywhere except on the highest elevations, and producing an aggregate in comparison with which all the maize grown in the remainder of the world is quite insignificant. Kansas produces more than Roumania, Ohio more than Hungary, Pennsylvania more than France, and Michigan more than Italy. Illinois in 1879 produced nearly as much as the average crop of all Europe. The United States will, the present season, quadruple the European harvests. The area in maize has nearly doubled since 1870. The census reported the crop of 1869 at 760,944,549 bushels. The estimated annual average for six years, from 1871 to 1876, inclusive, slightly exceeds 1,000,000,000 bushels; for the last six years it falls but little short of 1,500,000,000 bushels. The average consumption for twelve years is about 1,150,000,000 bushels. The present requirement is about 1,400,000,000, and 100,000,000 exceeds the highest figures of exportation. But there is so much coarse material available, as substitutes in feeding, that the absolutely necessary consumption is difficult to fix. The yield per acre for twelve years has been 26 bushels, rarely rising much above or falling below that figure, though the average for last year was but 18.6 bushels, the lowest ever recorded; the next lowest, 20.7, that of the disastrous year 1874.

The loss of 500,000,000 bushels in 1881, reducing the supply 300,000,000 bushels below the requirements of consumption and exportation, sent up prices 60 per cent., and produced a determination to secure a large crop the present year. The lateness of the spring, rains and frosts of April and May, caused consternation for a time; but replanting, in many instances for the second time, resulted in some increase of area. July came, with the plants small and discolored from frost and excess of moisture, but improving. To show the condition from this date, the following comparison of condition with the census year is made:

Year.	July.	August.	September.	October.
1879	93	93	96	85
1882	85	83	83	81

With this statement in view, it is obvious at a glance that the yield cannot possibly equal that of 1879. As it was said in the September report, "the heavy production of 1879 and 1880 cannot be approached under the most favorable circumstances" of the later season; not very nearly—not within 8 per cent., or more than one hundred million bushels. The estimates of yield per acre, in November, following these reports of condition, made an average of between 24 and 25 bushels per acre, while the average yield of 1879 was between 28 and 29.

The December returns make direct comparison with the product of last year. In November the yield per acre was reported, and in October the last report of condition of the growing crops. The range of variation in results of these three separate tests is but 3 per cent. With so slight a difference, the tendency of more accurate information is towards reduction. The present and final returns aggregate in round numbers 1,625,000,000 bushels. The permanent estimates will be published after analysis of all records of area, condition and production of the year, and conscientious adjustment of all possible differences.

There is also much reduction in quality and intrinsic value in the Northwest from immaturity and injury by frost, especially in Iowa. The statistical agent of that State expresses the opinion that it will take three bushels to equal the value of two bushels of good corn.

The following table gives the production of 1882, by States, subject to such revision as the more thorough comparison of returns may render necessary:

States.	Bushels.	States.	Bushels.
Maine	904, 400	Tennessee	73, 188, 600
New Hampshire	870, 700	West Virginia	14, 927, 000
Vermont	1, 930, 300	Kentucky	79, 500, 900
Massachusetts	1, 237, 200	Ohio	93, 319, 200
Rhode Island	277, 900	Michigan	30, 081, 600
Connecticut	1, 155, 800	Indiana	107, 484, 300
New York	20, 687, 500	Illinois	187, 336, 900
New Jersey	9, 942, 800	Wisconsin	30, 201, 600
Pennsylvania	41, 518, 800	Minnesota	21, 127, 600
Delaware	3, 936, 600	Iowa	178, 487, 600
Maryland	17, 904, 700	Missouri	174, 037, 000
Virginia	35, 904, 000	Kansas	150, 452, 600
North Carolina	34, 260, 700	Nebraska	82, 478, 200
South Carolina	15, 856, 200	California	2, 790, 900
Georgia	29, 617, 500	Oregon	101, 000
Florida	3, 708, 900	Nevada	11, 700
Alabama	30, 982, 500	Colorado	422, 400
Mississippi	28, 233, 600	Territories	7, 500, 000
Louisiana	14, 636, 400		
Texas	63, 416, 300	Total	1, 624, 917, 800
Arkansas	34, 485, 900		

WHEAT.

The consumption of the present year (for 54,000,000 people) requires 250,000,000 bushels, for seed 57,000,000, leaving nearly 200,000,000 for exportation, and for filling the severely depleted stocks in first hands. Such surplus, even if 40,000,000 bushels, in view of the exhaustion of garner and local stocks at the end of the commercial year in August, would be less than that of two years ago, and would not depress prices.

The five preceding crops averaged (as estimated) 425,000,000 bushels per annum; the distribution of five years has averaged 429,000,000, the 20,000,000 difference having been drawn from stocks on hand, reducing the surplus of 1882 to that extent in comparison with the surplus of 1877. Of this distribution 145,000,000 has been exported per annum in wheat and flour, 51,000,000 was used for seed, and 233,000,000 consumed as food.

There was an increase of area in the South, where scarcely more than a tenth of the entire breadth has formerly been planted, producing scarcely one-twentieth of the crop. Intelligent planters there realize a necessity for a home supply of breadstuff; for years they have talked, and sometimes slowly acted in that direction; they are "always to be blest" with diversity and abundance, but each waits for his neighbor to "diversify," while he puts in an extra acre of cotton with the expectation of higher prices.

The Atlantic States made no increase in area, and the Western winter-wheat States suffered some decrease, as did also the spring-wheat States. This decline is largely in the southern counties of Wisconsin and Minnesota, and in the northeastern districts of Iowa. It is caused by the extension of dairying and stock farming generally, in accordance with an inexorable law of progress in agriculture, which compels the abandonment of one-idea cropping upon penalty of loss of profit.

There was general exemption from winter-killing, and the promise of a a good crop was early and positive. In July condition of winter-wheat averaged 104 and spring-wheat 100. The October returns indicated a yield of about 13½ bushels per acre, which has been rarely exceeded, the average being 12 bushels, and that of last year about 10 bushels. The preliminary estimates slightly exceed 500,000,000 bushels.

States.	Bushels.	States.	Bushels.
Maine	512,100	Tennessee	8,971,200
New Hampshire	148,700	West Virginia	4,854,200
Vermont	378,000	Kentucky	17,250,000
Massachusetts	20,100	Ohio	45,452,000
Rhode Island	....	Michigan	32,815,400
Connecticut	43,600	Indiana	45,461,200
New York	12,145,200	Illinois	52,382,200
New Jersey	2,098,700	Wisconsin	30,145,400
Pennsylvania	20,300,400	Minnesota	37,060,200
Delaware	1,200,600	Iowa	36,487,200
Maryland	8,655,600	Missouri	27,526,000
Virginia	8,311,400	Kansas	23,263,000
North Carolina	5,494,800	Nebraska	14,947,200
South Carolina	1,729,000	California	34,546,000
Georgia	3,812,900	Oregon	12,028,200
Florida	600	Nevada	49,400
Alabama	1,700,800	Colorado	1,506,200
Mississippi	250,100	Territories	16,000,000
Louisiana	7,000		
Texas	4,178,700	Total	502,780,000
Arkansas	1,566,100		

OATS.

This crop in its uses is so allied with corn that the low yield and high price of maize last season had its effect upon the price of oats, and the increase of value stimulated in turn the extension of area, so that 7 per cent. was added to the breadth. On the 1st of June the condition of the crop was higher than in any previous year since 1868. The only cereal crop that did not meet with disaster last year was exceedingly promising at the commencement of the present season, promising another large yield. In July the promise was still good of more than an average crop. There were some reports of the army-worm, aphis, and small insects at the roots popularly described as "midgets," in Maryland and Virginia. The army-worm was injurious in West Virginia, and in Missouri the chinch-bug appeared in some force.

The average of general condition kept up to 100 until harvest, *i. e.*, the average result, though varying in different States, equaled in the aggregate a full yield for all. This has happened but once in thirteen years, in 1877, when the average yield per acre was 31.6 bushels, and the average value only 29.2 cents per bushel, the lowest price for thirteen years with the exception of 1878, when with another crop of larger area and nearly as great a yield per acre, and a large surplus from 1877, the price fell to 24.6 cents in December.

The average yield from 1871 to 1881, inclusive, was 27.6 per acre, about a bushel more than the average yield of corn for the same period. The average price on the first of December has averaged 36.1 cents for the same term of years. From 1875 to 1879 the annual average was below this figure on account of good yields and increase of area. In 1880 enlarged demand brought the average to 36 cents, and in 1881 the scarcity of corn advanced it to 46.4 cents. With a large corn crop there would have been no advance. The yield per acre of the present crop is above an average of a series of years, and the product, with increased area, is the largest ever harvested in this country. The preliminary estimate of production in 1882 is as follows:

States.	Bushels.	States.	Bushels.
Maine	1,776,700	Tennessee	7,129,500
New Hampshire	1,030,090	West Virginia	1,678,400
Vermont	3,445,300	Kentucky	7,579,400
Massachusetts	708,000	Ohio	16,732,100
Rhode Island	155,800	Michigan	18,057,000
Connecticut	1,048,800	Indiana	18,696,000
New York	40,068,000	Illinois	99,141,000
New Jersey	3,808,800	Wisconsin	34,824,400
Pennsylvania	34,721,100	Minnesota	29,700,000
Delaware	391,800	Iowa	44,555,700
Maryland	1,658,900	Missouri	30,078,500
Virginia	3,551,400	Kansas	12,780,800
North Carolina	5,713,400	Nebraska	9,417,600
South Carolina	4,430,100	California	1,548,000
Georgia	7,285,800	Oregon	4,433,500
Florida	....	Nevada	193,800
Alabama	3,994,900	Colorado	902,000
Mississippi	3,080,800	Territories	3,000,000
Louisiana	527,800		
Texas	9,239,600	Total	475,655,700
Arkansas	3,181,500		

BARLEY.

There has been a small increase of area, enlarging to breadth slightly above two million acres, and an average yield has been obtained, making a crop of not less than forty-five million bushels, yet the supply does not suffice for home consumption. Though a small export trade is carried on, the importation is larger by millions of bushels. The percentage of the supply that is imported is greater than the percentage of any cereal product exported, wheat only excepted.

The average yield per acre of barley for a series of years has been found to be twenty-two bushels; it was greater in 1871, 1873, 1878, 1879, and 1880, and less in intervening years. It is nearly twenty-three the present year.

California, New York, and Wisconsin furnish more than half the acreage, and with Iowa, Minnesota, and Nebraska exceed three-fourths. Very little is grown in the South, usually, and the increase the present year is very small.

It is a noticeable fact that the only cereal of which the United States never produces a supply for home consumption is the one which yields a higher value per acre than any other. The average yield and value per acre for eleven years, from 1871 to 1881, inclusive, is thus comparatively presented:

Cereals.	Yield per acre.	Value per acre.
	Bushels.	
Corn	26.0	$11 30
Wheat	12.2	12 82
Oats	27.6	9 97
Rye	13.9	10 03
Barley	22.0	16 14
Buckwheat	16.1	11 37

A prominent reason for the higher value of product per acre is the fact that the cultivation of this grain is confined to the northern section of the country, where the yields of all cereals are higher. It is grown mainly in the fertile and improved districts of New York, the rich lands of the Northwest, and in California, on soils generally well adapted to the crop. From recent increase of area—the breadth having doubled in fifteen years—it would appear that the effort to keep pace with consumption would ultimately succeed. The imports are received from Canada, being grown principally near the State of New York, in which one-third of the beer of the country is manufactured. This proximity to the place of manufacture overbalances the duty on the grain. Barley is nearly all transported by rail or water, bearing charges of transportation, while four-fifths of the corn and oats are required for home consumption.

POTATOES.

The reduction of the supply of potatoes in 1881, amounting to about 70,000,000 bushels, and the unprecedented prices which followed such a failure, stimulated the effort to achieve independence of foreign growers, who received nearly five million dollars for a quantity (8,789,860 bushels) that only made good one-eighth of the deficiency; and the result was naturally an increase of area amounting to 7 per cent. This crop is becoming more important than ever before in the South. Potatoes have formerly been grown very sparingly, in gardens only, and used for a few days or weeks in the spring as a vegetable of positive rarity. Their use has increased of late, and their shipment North as an early product is increasing with the development of railroads and the tendency to "trucking;" but it is a lesson that has been well learned that garden vegetables, roots and the small grains, all products which flourish in higher latitudes, must be grown in autumn, in winter, or early spring, before the heats of summer reach their greatest elevation. So potatoes are planted on the Gulf coast in December or January; a little further north at a somewhat later date, adapting the time of ripening to the close of the season's moderate temperature. But there has sprung up a practice, which should be encouraged, because it renders possible a winter supply for the masses, promising to increase immensely the consumption of this valuable food product which cannot endure the heats of summer. This practice is worthy of general extension, and it should give the Irish potato a place side by side with the sweet potato as a winter food for every day's consumption. It is by late summer planting and early fall growth, ripening before frost. In high latitudes and elevations there has been some difficulty in getting an autumn crop fully matured. By making two crops, one in winter and early spring, the other in the autumn, it is possible to have a continuous supply, and seed potatoes grown at home, instead of being brought from the North as formerly.

The crop started well, and in July its condition was 102. The great potato regions were reported: New York, 98; Ohio, 102; Michigan, 99; Indiana, 105; Illinois, 104; Iowa, 101. On the first of August the average was 101. A great reduction usually occurs in August, the month of droughts, and this season was not altogether exceptional, the average of condition falling to 92 in September, and to 81 in October.

In New York condition declined to 70, and ranged 70 to 85 in New England, the result of drought. In New Jersey, where the drought was somewhat less severe, it was 82. The promise continued high in the Ohio Valley and in Michigan, but declined somewhat in the States of Wisconsin, Minnesota, and Iowa.

Last year the decline in August was from 92 to 70, falling to 6 on the first of October, the yield per acre falling to 53.5 bushels per acre, the lowest ever recorded, the highest being 110.5 in 1875, and the average of eleven years 84.2 bushels per acre. As the supply governs the price, the average was, of course, unprecedented, being 90 cents per bushel in December, while higher prices ruled for a portion of the consumption remaining at a later date. The lowest average December price in eleven years was 38.9 cents in 1875, and the average for the period 56.1 cents. The average value per acre, for the same period, is $47.08. Small as was the crop last year, the average price was $48.63, which has not been exceeded in any season since 1874, illustrating the fact that partial failure of a crop does not reduce the income received from it. While this is true as a rule, it does not mitigate the hardship of individual losses, which are distributed among the careless and unskillful farmers, the enterprising cultivators usually getting good crops and high prices, and reaping rewards instead of suffering damage.

COTTON.

In 1879 the area in cotton had reached 14,480,000 acres, by census returns. The unofficial estimate of the undersigned, after a series of official estimates, from 1866 to 1877, inclusive, was 14,500,000 acres prior to the census tabulation. The following are his official estimates for the succeeding three years:

States.	1882.		1881.		1880.	
	Per cent.	Acres.	Per cent.	Acres.	Per cent.	Acres.
Virginia	107	61, 985	109	57, 930	118	58, 147
North Carolina	99	1, 050, 543	109	1, 061, 155	109	973, 537
South Carolina	98	1, 587, 244	106	1, 619, 639	112	1, 527, 959
Georgia	95	2, 844, 305	104	2, 994, 005	110	2, 878, 851
Florida	99	260, 402	102	263, 032	105	257, 875
Alabama	96	2, 534, 388	103	2, 639, 988	110	2, 563, 095
Mississippi	95	2, 233, 844	104	2, 351, 228	108	2, 260, 796
Louisiana	94	887, 524	103	944, 174	106	916, 674
Texas	105	2, 810, 113	108	2, 676, 298	114	2, 478, 054
Arkansas	94	1, 110, 790	103	1, 181, 692	110	1, 147, 274
Tennessee	97	815, 760	103	840, 990	113	816, 495
Other States and Territories	99	79, 793	105	80, 599	110	76, 761
	97. 4	16, 276, 691	104. 8	16, 710, 730	110	15, 950, 518

The increase was 10 per cent. in 1880, nearly five in 1881, and in the present year a small decline is reported in every State except Texas, the largest in production, and Virginia, one of the smallest. The overflow on the Mississippi caused some reduction of area, and in the other States a prevailing conviction that cotton had become comparatively too prominent for the highest profit in the distribution of crop areas. While this conviction appeared to be general among intelligent growers, the old habit of too exclusive cotton-growing was too strong to effect much reduction. Similar views have been entertained less generally for years, with a constant increase of cotton area. It is therefore not surprising that the reduction is only 2 or 3 per cent.

The planting season was not favorable, temperature being low in April and May, and moisture excessive, causing deficient stands, replanting, slow growth, and unthrifty appearance. With such conditions, the aphis flourishes and rust appears. The June report averaged the lowest condition at that date since 1874. The July report showed decided improvement, with condition within one point of the July average of 1877 and 1879, but not equal to that of 1880. It was noticed that there was an entire absence of unhealthful conditions. The plants were uniformly vigorous and thrifty, rendering possible a large crop, with a continuance of favoring weather, which fortunately was enjoyed in a high degree, so that the August return was 94 against 91 in August of the census year. In September 92 was reached, the same as in 1880, a figure higher than in any other September of the last ten years. In October, after the first picking, when the effects of drought, storms, and floods, and ravages of insects are seen and calculated, there is almost invariably seen a reduction in averages of condition. This year the average was 88 against 66 in 1881, 84 in 1880, and 81 in 1879. These figures give a good idea of the fruitfulness of these respective seasons at that date, though the ultimate result is modified by three months of further development and harvesting. The indications of October were substantially those of November following, when the yield per acre was given looking to a crop of 6,636,600 bales of 460 pounds of net lint, or 490 pounds gross. This is not given as an estimate by the Statistician, but as the result of the returns of November carefully revised and consolidated. The final report, showing the conclusion of the picking at its close, is not yet made. The figures of yield per acre make the following aggregates:

States.	Acres.	Yield per acre.	Pounds of lint.
Virginia	61, 985	178	11, 033, 330
North Carolina	1, 050, 543	180	189, 097, 740
South Carolina	1, 587, 244	183	290, 465, 652
Georgia	2, 844, 305	152	432, 334, 360
Florida	260, 402	117	30, 467, 034
Alabama	2, 534, 388	150	380, 158, 200
Mississippi	2, 233, 844	190	424, 430, 360
Louisiana	887, 534	235	208, 568, 140
Texas	2, 810, 113	240	674, 427, 120
Arkansas	1, 110, 790	233	258, 814, 070
Tennessee	815, 760	170	138, 679, 200
Missouri, Indian Territory, &c	79, 793	180	14, 362, 740
Total	16, 276, 691	187	3, 052, 837, 946

The serious injury justly apprehended from lateness and vigor of growth did not occur. Killing frosts were everywhere later than usual, yet loss of immature bolls, in some districts estimated at 10 per cent., resulted in parts of North Carolina, Tennessee, Arkansas, and Northern Texas, and in a less degree in other States of the cotton belt. In Northern Mississippi frost was reported twenty to thirty days later than in average years. The weather has been generally favorable for picking; at many points exceptionally good. The reverse has been true in portions of Louisiana and Northern Texas, in some counties of Arkansas, and other parts of the Southwest, from continued wet weather. Losses from the boll-worm continue to be reported, mainly west of the Mississippi. This insect has probably caused as much damage as the caterpillar this season.

SUGAR PRODUCTS.

The season has been unusually favorable for the growth and maturing of sugar cane, and one of the largest crops of recent years is assured. The Department returns of results have not yet been received, as it is yet too early to obtain full data of the manufacture. The indications, however, favor an aggregate of the Louisiana crop exceeding 200,000 hogsheads of sugar, probably not less than 250,000,000 pounds.

The sorghum experiment has resulted the present season in the production of a good grade of sugar, manufactured at an apparent profit, in three factories, one of which produced 319,000 pounds, and in experimental production of small quantities at several points in the Northwest. The aggregate will exceed half a million pounds.

Beet sugar has been made successfully for three successive seasons in California, at one factory. The Maine factory, which was in operation three years, producing in one season 1,200,000 pounds, and in another 1,000,000 pounds, was obliged to suspend operations for want of beets, which farmers, inexperienced in sugar-beet culture, thought they could not afford to produce at the prices, viz, $5 to $6 per ton, the average production being ten tons per acre.

The season has been favorable for the production of a good quantity of sorghum sirup, and the reports concerning quality indicate gradual improvement in the methods of defecation and clarifying. There has been a marked increase in area in some sections of the South and West.

SEEDING OF WINTER GRAIN.

The returns of December relative to winter wheat and rye show a very small increase of area. In the South there is little increase, except in Virginia, North Carolina, and Texas. Kentucky and West Virginia have enlarged their area, and Kansas has made some increase.

In some parts of the Middle States the autumn was somewhat too dry, but the crop is generally in good condition. It is looking fairly well throughout the South, though the sowing has been later than usual. In parts of Texas the weather has been too dry, and the pressure for cotton picking has been an obstruction in some districts. Condition is good throughout the West, nearly up to the normal standard of full vitality.

The Hessian fly attacked early sown wheat in Delaware. The fly has injured some fields in the Shenandoah Valley and in Southwest Virginia. Frequent mention is made of similar damage in Tennessee and Kentucky. In Ohio such reports are less frequent, yet the fly has made its appearance at many points. In Indiana, Illinois, Missouri, and Kansas early sown wheat has been attacked, but the injury has not generally been severe, and is nowhere considered irreparable.

In the more Southern States seeding was not completed on the first of December, so that the present report cannot indicate fully the comparative area, which can be more satisfactorily shown in the return of next April.

CONCLUSION.

The estimates of various minor crops of 1882 are not yet completed, but will be given soon in a special report, together with the general estimates of area and local values, with deductions of yield per acre, value per bushel, per acre, &c.

The comparative numbers and value of the different farm animals will be returned in January, 1883, and will be included in the same report.

J. R. DODGE.
Statistician.

Hon. GEO. B. LORING,
Commissioner.

REPORT

OF

THE COMMISSIONER OF AGRICULTURE

FOR 1882.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., November 20, 1882.

To the President:

I respectfully submit the annual report of the Department of Agriculture for the year 1882.

During the past season the work of the department has been vigorously prosecuted on the line laid down in my communication of November 25, 1881. I have made personal investigation of the condition of farming in most of the great agricultural States of the Union, and have been deeply impressed by the energy and skill with which the industry is conducted and the manifest success which attends it, as evinced by the prosperous appearance of the lands and homesteads of the people. I have visited as many of the agricultural colleges as possible, and have endeavored to impress upon these institutions the desire of the department to co-operate with them in their efforts to diffuse sound practical information throughout the country for the benefit of those who are engaged in conducting our great industrial enterprises and developing the enormous wealth of our resources. And whenever an object of importance connected with the industry which this department represents has presented itself, I have employed competent investigators to explore and report. The liberally increased appropriations made at the last session of Congress for the benefit of the department have been used in such a manner as seemed most promotive of the objects which that body had in view, and the expenditures have been confined strictly to the divisions and work for which the appropriations were specifically made. Provision has been made for the care and protection of the valuable collections of minerals, ores, woods, and agricultural products presented to the department by the exhibitors at the Atlanta Exposition of 1881, and in a temporary and convenient building on the grounds of the department these collections have been admirably arranged for easy access by those who desire to witness the producing capacity of those sections of our country which have furnished the exhibits.

A new building is nearly completed for the storing and distributing of the large amount of seed now provided by Congress.

The success which attended the conventions held at the department in January, 1882, has induced me to call others in January, 1883, to which representatives of the agricultural colleges and societies have been called together for the purpose of discussing the most important points relating to agricultural education, the animal industry of the United States, and the cotton industry.

I have received through the State Department a communication from Hamburg, requesting this country to unite with the great agricultural nations of Europe in an exhibition of domestic animals, and the various methods of feeding and plans for shelter, in July, 1883, which I trust will receive the consideration of Congress.

DIVISION OF GARDENS AND GROUNDS.

The number of plants distributed since my last report amounts to about 70,000. The seeming falling off in numbers from those of recent years is due to the reduction of the number of tea plants, that distribution being partly met with plants from the tea nursery in South Carolina. Compared with the amount of appropriation available for this particular work, the number of plants propagated is large, and as they are mainly packed so as to be sent through the mail, a considerable amount of labor is required. About 4,500 packages, averaging 15 plants to each package, necessarily involves much manipulation in their preparation for the post-office.

Attention is again directed to the necessity of establishing branches of this division in semi-tropical climates for the more extensive propagation of semi-tropical plants. The demands of the country for plants of this character for the purposes of experimentation are constant and persistent, and as the department is at present situated in regard to facilities and encouragement in the propagation of such plants, but little of essential value can be done.

The distribution of economic plants is prosecuted to as great an extent as the capabilities and appropriations for this particular purpose will admit. Efforts towards the introduction of the tea plant are vigorously maintained. The tea plantation instituted in the spring of 1881 is progressing favorably. Several acres have been planted and the plants are making a satisfactory growth, so that in the course of a few years they will be in good condition to fairly test the question of profitable manufacture, which is, in fact, the only point now awaiting consummation, the question of the adaptability of climate to the mere growth of the plant having long been favorably determined.

BOTANICAL DIVISION.

The work of the botanical division has been steadily pursued throughout the year. Good progress has been made in preparing and mounting specimens and incorporating them in their proper places in the herbarium, thereby rendering available for study and consultation a large number of new specimens.

The collection has been largely increased during the past year by the purchase of plants from Florida, Arizona, New Mexico, Texas, and the Pacific slope, and a few from other points. Several packages of Arctic plants have been received through the Smithsonian Institution, and numerous small packages from various persons, part as donations, part as exchanges.

Packages of plants have been sent out to individuals as exchanges, also to persons making a special study of some order of plants, and to institutions of learning. The work of describing and illustrating our native grasses for the annual report has been continued, preference having been given to those species concerning which special inquiries have been made during the year by agriculturists and stock-raisers.

Circulars making inquiries concerning the various species of grass relied upon for hay and grazing were sent to the Southern States, to the Pacific slope, and to the Territories. Much valuable information was obtained, a digest of which is given in the annual report.

MICROSCOPICAL DIVISION.

During the past year the work of the division has been of the usual varied character. Many microscopical examinations have been made of breadstuffs, milk, butter, cheese, sugar, glucose, oleomargarine, food oils, lard, vegetable fats, &c., and in some instances new methods discovered for the detection of artificial impurities in them.

Investigations have been instituted to discover, if possible, the primary cause of what is known as pear-tree blight, so destructive to the interest of orchardists in the Northwest, where sometimes a thousand valuable pear trees are destroyed by this disease in a single orchard in a season. A large collection of microscopic sections have been made and mounted to illustrate the distinctive peculiarities of different species of oaks. These investigations have a special commercial and botanical value.

The microscopist has also made investigation for several divisions of the department, and in some instances for the general government. Correspondence has also been kept up with eminent European microscopists as well as those of the United States, and specimens having relation to the work of this division exchanged.

CHEMICAL DIVISION.

The work of the chemical division has been devoted largely to investigating the sugar-producing qualities of sorghum, beets, and other plants, as provided for by Congress. The analyses of last year have been repeated, and many varieties of sorghum raised on the grounds of the department have been subjected to careful laboratory examination.

The laboratory work of 1882 will be necessarily extended beyond the time fixed for the issue of the forthcoming volume, and must therefore be retained for a future publication. Thirty-five new varieties of sorghum from Natal, India, and China have been subjected to daily examination, and I am informed by the chemist of the department that preparation is made for analyses of nineteen varieties of bagasse, four varieties of leaves, twelve varieties of juices, twenty-five varieties of sirups from sorghum, together with three hundred and fifteen vegetables, fifty specimens of wheat, and twenty-five of soils, during the immediate future.

Fifty-four miscellaneous analyses, including minerals, spring and well waters, peats, soils, cereals, shales, kaolins, fertilizers, tanning materials, waste products of glucose manufactories, marls, &c., have been performed during the last season, and several hundred determinations of water, nitrogen, and proximate principles have already been made on the vegetable samples enumerated, and an increasing amount of correspondence has received constant attention.

At the request of the chemist of the department, I submitted the sorghum analyses and work of his division to the National Academy of Sciences on the 30th of January last for investigation by that body. A committee appointed for that purpose entered upon their work with great zeal and energy, and their report, which was laid before me, was, on July 21, withdrawn formally by the secretary of the academy, "for such action as the academy may deem necessary." On the 15th of November current, the president of the academy presented to me the final report of that institution, a long and elaborate document, containing a review of the history of the sorghum industry for twenty-five years, a statement of the scientific investigations made in this country and in Europe into the quality of sorghum and maize as sugar-producing plants, a careful examination of the chemical work of the department, a large volume of testimony received from sugar manufacturers, and certain suggestions with regard to future investigations and the work of the department. This report is evidently the result of infinite care, and has been subjected to careful revision, and I trust it will be found a valuable text-book for those engaged in the sorghum sugar industry. As a review of the successes and failures which have attended this industry, it is invaluable. As a guide to those who are engaged in it, it contains all the important results that have thus far been obtained by the chemist in his laboratory and the manufacturer in his mill. This report, together with a most voluminous appendix, making an interesting mass of matter far too large to be inclosed in the annual volume of the department for this year, will be issued at an early day as a special publication.

The business of manufacturing sugar from sorghum at the department having failed in 1881, and having furnished discouragement rather than information to those engaged in it, I have called upon the sorghum manufacturers themselves for such information as they could furnish in an accurate manner, for the benefit of the industry they represent. I have also made the same request of the manufacturers of sugar from beets. I have received assurances from nearly a hundred manufacturers that they will contribute to this work, and I feel confident that I shall in this way receive a great amount of valuable information.

I have endeavored from the beginning of my connection with the department so to conduct the work performed here as a part of that interesting investigation into the value of sorghum now going on in the field of the farmer, and the mill of the manufacturer, and the laboratory of the chemist, as to secure for what appears to be a growing industry all the information which unprejudiced science and the best practical skill can provide; and I trust the knowledge I have gathered will, when published, be found to be of value.

ENTOMOLOGICAL DIVISION.

The work of the entomological division has progressed satisfactorily during the year. The report of the entomologist includes observations on many insects that have attracted attention during the year, while special study has been given to those affecting the principal staples. Yet the observations on these form but a small part of the work of the division, since unpublished notes of observations and experiments have been made on 590 different species more or less injurious, and about which little or nothing was hitherto known, while many additions have been made to our knowledge of the habits of species that had previously been but partly studied.

The chief staples have during the year suffered comparatively little, as a rule, from destructive insects. Yet many serious complaints have come from several sections, and the entomologist has given particular attention to such, visiting the localities that suffered either personally or by proxy.

The aggregate damage done to our products by injurious insects is enormous, and few fields of inquiry promise more substantial and practical results than systematic and intelligent investigation into the habits of these tiny marauders, and the best means of counteracting their ravages. As an evidence of the interest in and appreciation of the work which the department is doing in this field, some 2,500 letters of inquiry have been received during the year, most of them requiring full replies. This correspondence consumes a large share of the time of the entomologist and his assistants.

The United States Entomological Commission has ended its field work and has well-nigh completed its office work. The third report of the Commission has been finished and placed in the printer's hands, and the fourth, which is a revised edition of Dr. Riley's report on the cotton worm, has been delayed so as to include the practical results obtained during the present year. The fifth, which is a revised edition of Dr. Packard's report on the insects affecting forest trees, is in course of preparation.

In addition to the above documents several bulletins on important insects are being prepared, as also a bibliography of economic entomology, and a special report on the insect diseases affecting the orange. Special agents under the direction of the entomologist have been engaged in several widely separated parts of the country making observations and experiments on species affecting the orange and the cotton interests; while a party has explored the northwest regions of the United States and British America with a view of obtaining data in reference to that scourge of the West, the Rocky Mountain locust.

The course of exploration was through Dakota and Montana to Fort McLeod and back down the South Saskatchewan via. Winnepeg—the object being to depart from beaten routes and to make excursions, by the way, into the great plains. The results of the journey warrant the conclusion that the destructive insect is yet in altogether insufficient numbers in these, its native haunts, to threaten any serious migrations or injury to crops in the more fertile States to the southeast.

Dr. Riley has for some years past made it a point to endeavor to collect such data as would warrant anticipation of locust injury or immunity, and the anticipations, as set forth on repeated occasions, have been verified in a remarkable degree.

The farmers of the West have, therefore, so far as the data obtained warrant an opinion, the pleasing assurance that their crops will not be ravaged by locusts in 1883.

The army worm appeared in injurious numbers in several of the Atlantic States, and its advent the present year was also anticipated by the entomologist, who endeavored, through the columns of the agricultural press, to prepare farmers for the visitation. In like manner timely information in reference to the cotton worm was disseminated among the planters of the overflowed districts of the Mississippi Valley in anticipation of possible injury, and the subsequent immunity from injury was no doubt largely due to the preparation for meeting the evil in its incipiency which planters in consequence made. Important improvements in the machinery used in poisoning this insect have been made, and the interesting and mooted question as to whether or not the parent of the worm survives throughout the year within the limits of the United States has been definitely settled in the affirmative.

Among other subjects worthy of mention in connection with the entomological division is the introduction and cultivation of the pyrethrums, which are known to have such great value as insect destroyers, and the powder from which is variously sold under the names of "Persian Insect Powder," "Buhach," &c. The entomologist has ascertained by experiment that preparations of this plant may be used successfully in the field against several of our worst insect pests, and its cultivation over as wide an area as possible is, consequently, most desirable. A circular giving information about the two species having this virtue was accordingly sent out, with seed that had been imported from Russia and the Caucasus. The experience so far had by the recipients of the seed is, on the whole, most encouraging, as is also that had at Washington, where plants of both species, grown from seed sown in the fall of 1880 and spring of 1881, flowered profusely and gave a powder equal in its insecticide qualities to any previously tested.

DISTRIBUTION OF SEEDS.

Tabulated statement showing the quantity and kind of seeds issued from the seed division, Department of Agriculture, under special appropriation act of Congress passed April 11, 1882, of $20,000 for the flooded districts south.

DESCRIPTION OF SEEDS.

	Packages.
Vegetables	414,886
Field corn	48,644
Field pease	26,957
Field beans	3,964
Field millet	14,348
Field cotton	159
Grand total	508,958

RECAPITULATE.

Senators and Members of Congress	1,058,479
State agricultural societies	7,588
Statistical correspondents	269,177
Special appropriation	508,958
Miscellaneous applicants	552,274
Grand totals	2,396,476

Tabulated statement showing the quantity and kind of seeds issued from the seed division, Department of Agriculture, under the general and special appropriation acts of Congress from July 1, 1881, to June 30, 1882, inclusive.

Description of seeds.	Varieties.	Senators and Members of Congress.	State agricultural societies.	Statistical correspondents.	Special appropriation, $20,000.	Miscellaneous applicants.	Grand total.
		Packages.	Packages.	Packages.	Packages.	Packages.	Packages.
Vegetables	107	719,855	....	150,943	414,886	366,020	1,651,704
Flowers	86	75,627	....	3,327	....	100,498	179,452
Herbs	15	....	....	4	....	212	216
Tobacco	7	62,447	....	835	....	19,933	83,215
Tree	8	381	....	159	....	535	1,075
Sunflower	1	....	....	90	....	166	256
Opium poppy	1	....	....	6	....	48	54
Pyrethrum	1	....	....	....	....	2,017	2,017
Grape vine	5	10,246	....	....	....	678	10,924
Strawberry	4	14,029	....	....	....	806	14,835
Tea seed	1	54	....	....	....	....	54
Coffee	1	435	....	....	....	4	439

Tabulated statement showing the quantity and kind of seeds issued from the seed division, Department of Agriculture—Continued.

Description of seeds.	Varieties.	Senators and Members of Congress.	State agricultural societies.	Statistical correspondents.	Special appropriation, $20,000.	Miscellaneous applicants.	Grand total.
FIELD SEEDS.		*Packages.*	*Packages.*	*Packages.*	*Packages.*	*Packages.*	*Packages.*
Wheat	15	52, 847	6, 084	33, 232	....	5, 788	97, 951
Oats	5	40, 684	1, 408	12, 619	....	20, 563	75, 274
Corn	18	19, 081	....	15, 230	48, 644	9, 942	92, 897
Barley	1	29	....	....	....	366	395
Buckwheat	1	8, 503	....	5, 162	....	4, 715	18, 380
Rye	1	82	....	10, 274	....	659	10, 965
Sorghum	19	2, 377	....	692	....	3, 503	6, 572
Sugar-beet	1	....	....	85	....	1, 416	1, 501
Mangel wurzel	1	....	....	89	....	66	105
Grass	5	562	64	997	....	2, 883	4, 506
Clover	4	279	8	139	....	828	1, 254
Cow-pea	1	....	....	67	....	133	200
Richardsonia scabra	1	....	....	16	....	43	59
Borage	1	....	....	8	....	5	13
Millet	1	....	....	....	14, 348	2	14, 350
Rice	1	....	....	2	....	46	48
Turnips, special issue	5	35, 700	....	35, 000	....	....	70, 700
Beans, special issue	9	....	....	....	3, 964	....	3, 964
Pease, special issue	9	....	....	....	26, 957	....	26, 957
TEXTILE.							
Cotton	5	20, 257	24	230	159	10, 103	30, 773
Hemp	2	....	....	....	....	46	46
Flax	1	....	....	....	....	12	12
Jute	1	54	....	21	....	228	303
Ramie	1	....	....	....	....	10	10
Grand total	......	1, 058, 479	7, 588	269, 177	508, 958	552, 274	2, 396, 476

DISEASES OF DOMESTIC ANIMALS.—WORK OF THE VETERINARY DIVISION.

The failure of the corn and hay crops last year resulted in the loss, during the following winter months, of large numbers of farm animals. Since the opening of spring and the reappearance of grass, however, the past season has been an exceptionally favorable one for all classes of domestic animals. If we except Texas fever of cattle, no widespread epidemic has prevailed among any class, and the aggregate loss from disease will be less than in many former years.

Contagious pleuro-pneumonia still prevails among cattle in the States heretofore infected, but the area of the infected territory does not seem to have been extended during the year.

An outbreak of disease occurred in a large herd of cattle in Culpeper County, Virginia, in October last. It was thought to be Texas fever, and Dr. Miller, a competent veterinarian, was directed by the department to visit the locality of the outbreak and afford such relief as was in his power. On his arrival he found but two animals remaining on the place, and they were reported as being in a healthy condition.

A number of cattle had died, and in order to protect himself from further loss the owner had shipped all those that showed no evidences of disease to the Baltimore cattle market.

From all the information the inspector of the department was able to glean respecting the symptoms of the malady and *post mortem* appearances of the animals, he was led to believe that the disease was contagious pleuro-pneumonia, or lung plague. However, as he saw no sick animals and had no opportunity of making a *post mortem* examination himself, the identity of the disease must remain in doubt.

A number of both acute and chronic cases of lung plague were found by the inspectors of the department during their examinations of the past season in the States of New Jersey and Maryland. In the early part of the season a few cases were reported from Pennsylvania, caused by the importation of diseased or infected cattle from Maryland.

Texas fever of cattle prevailed over a wider extent of country during the season just closed than for many years. But few of the northern and border States escaped its ravages. The department sent members of the veterinary corps to a number of localities in Virginia, West Virginia, Ohio, Illinois, and Kansas, where the disease was reported as prevailing in a most destructive form, for the purpose of instituting such precautionary and preventive measures as would most quickly suppress the malady by preventing its further extension. In addition to this the department issued special report No. 50, which it widely distributed among the farmers and stock-raisers where southern cattle are usually grazed during the summer and fall months. This monograph contained, in addition to the report of Dr. W. B. E. Miller, a valuable paper from the pen of Dr. D. E. Salmon on the best means for controlling the contagion by the prevention of its further extension.

In addition to investigations of sporadic outbreaks of disease in widely separated localities, those employed by the veterinary division have continued the investigation of fowl cholera, swine plague, Texas fever of cattle, and a number of contagious diseases incident to sheep, with a view to determining their cause and the discovery of a remedy or preventive for the same. Dr. Detmers has spent the greater part of the year in Texas in the study of the peculiar fever which seems to have its home in the bodies of cattle raised in that State, and of some of the more destructive contagious diseases that yearly destroy thousands of sheep in the extensive ranges of the South and Southwest. The experiments with contagious diseases generally are of a very delicate nature, and the results sought necessarily of slow attainment. This seems especially the case with Texas fever of cattle, but as the end sought is one of such great importance to the future cattle interests of the country, the small sum annually expended in efforts to discover the true virus of the malady will be considered of no consequence in comparison to the great benefits which must result should these efforts eventually be crowned with success.

While Dr. Salmon has been studying the nature of the contagious and infectious diseases which are so fatal to the various species of live stock in the different parts of the country, in order that we may know exactly what causes them, how this cause is distributed from place to place, and what are the most efficient and practical means of destroying it, he has had another and equally important object in view.

It is now certain that with most of these diseases the living animal may be brought into a condition to completely resist the effects which usually follow exposure to the virus; that, strange as it may appear, animals may be rendered perfectly safe though they are exposed on every side to the germs of our most fatal diseases.

From the first he has been endeavoring to perfect the means of obtaining this desirable result, and although the investigation has been an extremely difficult one, some very satisfactory discoveries have been made. A new and very practical method of lessening the effects of the most virulent virus has been developed, which is very manageable with chicken cholera, and which it is believed is applicable to other diseases.

Inoculation with such attenuated virus is only followed by a slight local irritation, and when this subsides the individual is found to have acquired a very complete degree of insusceptibility. As soon as the details concerning this are worked out it will be possible to furnish vaccine from the department with which the farmer in different parts of the country can protect his animals from, certainly, a number of the plagues which are now so destructive, and it is hoped that this will be true of all the important ones.

The experiments with Texas or Spanish fever of cattle seem to have demonstrated very conclusively that this disease may be successfully inoculated by using material obtained from the spleen of sick cattle. A peculiar micrococcus has been found in this material and cultivated outside of the body, but in such cultivations it loses its virulence. Experiments will soon be undertaken to learn the reason of this, and to discover, if possible, a vaccine that will protect the cattle exposed to infected pastures. The investigations of the year have shown that a large part of the State of Virginia is permanently infected with this disease, and that cattle from this district are as dangerous as those from Texas. It was ignorance of this fact that led to the enormous losses of cattle in that State during the past summer.

The extension of the territory permanently infected by this plague, a fact first established by the investigations of this department, has been abundantly confirmed; the border line of the dangerous district is advancing across the previously healthy country at the rate of from one to four miles per annum.

Notwithstanding the importance of this fact the people most directly interested have scarcely suspected it, and much less have they attempted any effective means to check such extension. It is believed that the investigations now in progress will clearly outline this district and will furnish sufficient data bearing upon other points of the question to enable the interested States to make intelligent and effective laws for holding this dangerous plague in check until we learn sufficient in regard to its nature to enable us to attempt its extermination with some hope of success.

What has been discovered by the investigation of this disease cannot fail to be of the greatest value, not only to the affected district but to the country at large. It has been generally supposed that the only cattle capable of infecting northern pastures were those from the neighborhood of our South Atlantic and Gulf coasts from South Carolina to Texas; but it is shown that this dangerous district has advanced until it includes nearly all of North Carolina east of the Blue Ridge, and has even crossed the James River in Virginia.

It has never heretofore been doubted that the contagion of Texas fever was destroyed by frost and could not survive the winter in sections where freezing weather occurred; but it is now demonstrated that this view is incorrect, that in many parts of the infected district it resists severe winters, and that as it advances northward this power of resistance is gradually increased.

These extremely important facts show the necessity of continuing this investigation until we have acquired the means of controlling, if not of exterminating, the contagious diseases which are on the increase among our animals, and which threaten to destroy the great advantage which the farmers of this country have heretofore enjoyed in the live-stock industry. Detailed reports of the results of the work undertaken and prosecuted during the year will be submitted hereafter.

The call upon the department for veterinary investigation, during the year 1882, has been very great. The sudden and unaccountable outbreak of disease among domestic animals has been a matter of great anxiety in many portions of the country. As the number of our cattle, horses, sheep, and swine increases, the outbreak of contagious diseases also increases. The annual disturbances, moreover, incident to the work and confinement to which all classes of animals are subjected, which are held in immediate domestication, also increase as our population grows more and more dense.

To meet the calls which this state of affairs creates, I have been obliged to depend on such temporary and outside service as I could obtain. The absence of a well-organized veterinary division has been severely felt in the department, and it is of the utmost importance that such a division should be established, in which all investigations can be directed by a competent head, and on which the owners of live stock can call for counsel and aid. It is important to know the precise extent of existing disease. It is important to know how to guard against the spread of contagion and how to provide for its removal. It is important to know, if possible, the most economical remedies for disease, and how best to avoid the vast annual loss of animals from bad treatment and exposure. It is important also to ascertain, by the most careful investigation, the breeds best adapted to different localities and purposes in our country. To do this a well-organized division of veterinary inquiry and animal industry in this department is absolutely necessary.

DIVISION OF STATISTICS.

The division of statistics has pursued its general and special lines of effort, during the year, with new energy and persistence. Following a year the most disastrous to production known in the recent history of American agriculture, it has been the more difficult to mark accurately resulting changes in area and production of the present season, which has been one of extraordinary character, threatening throughout the planting season another year of comparative failure, from supersaturation of soils and river overflows, and thenceforward repairing continuously the early loss of condition by seasonable moisture and requisite sunshine, with little deterioration from storm or flood, drought or insect depredations.

From Maine to New Jersey on the Atlantic coast, an exception occurs in the prevalence of drought through the months of July and August. The unusual lateness of killing frosts crowned the record of the season's favors and secured a medium to full supply of all the various crops of the farm.

In recent years the aggregate production of cereals has reached a maximum of about 2,700 millions of bushels. Last year it fell nearly to 2,000 millions. The present crops, with some increase of area, will make nearly 2,700 millions. It is too early for the complete estimates of the year, but the results will be close to the following figures, which are given in connection with those of 1881 and the census results for the year 1879.

Cereals.	Department of Agriculture.		Census.
	1882.	1881.	1879.
	Bushels.	*Bushels.*	*Bushels.*
Corn	1,635,000,000	1,194,916,000	1,754,861,535
Wheat	510,000,000	383,280,090	459,479,505
Oats	470,000,000	416,481,000	407,858,999
Barley	45,000,000	41,161,330	44,113,495
Rye	20,000,000	20,704,950	19,831,595
Buckwheat	12,000,000	9,486,200	11,817,327
	2,692,000,000	2,066,029,570	2,697,962,456

There has been an increase of corn in the South, but in Illinois and Iowa a decline from the census crop of more than two hundred million bushels. The average yield per acre of corn will be nearly 25 bushels, about two bushels less than an average. The yield of wheat will be about 13½ bushels per acre, or 1½ bushels more than average. The product of cotton will probably equal that of the year 1880 (which was the largest ever made) and may slightly exceed it, approximating seven million bales.

A plan for completing and perfecting the system of crop-reporting, for which appropriation was made at the last session of Congress, has been put into operation, with initiatory results which promise success. It includes the appointment of State statistical agents, each at the head of a corps of reliable and judicious correspondents, who make simultaneous return, on the first of each month, both to the agent and the department. The agent is further charged with any special investigation that may from time to time be required, and with the collection of results of local experiment, and any valuable facts illustrating the progress of agriculture.

The design is, by establishing a permanent system of efficient and prompt collection of current statistics, to be able to present instantly and accurately the current changes in crop areas and conditions, and in production of breadstuffs, meats, industrial products, and all results of agricultural labor.

In obedience to requirement of Congress, there have been published, for three months past, statements showing the through rates of transportation by railroad and steamboat companies on all the principal routes, including the great trunk lines, the Pacific roads, and the north and south roads, and the coast lines of steamers upon the principal products of agriculture.

The local rates have also been given on all the prominent lines, and special freight rates have also been given. The railroads have responded with satisfactory promptness, furnishing freely their through and local tariffs, freight classifications, routes, and connections, and other information concerning their roads.

It has been found necessary to establish a European agency for collection of statistics showing prospective demand for American products, especially of grain and meats, for the information of farmers of the United States. This agency promises great efficacy and utility. Its headquarters is established at the office of the consul-general at London.

FORESTRY DIVISION.

A report from the forestry division was laid before Congress on May 12, 1882, and has been printed. It deals with the care of forests upon the public lands, experiment stations for forest culture, meteorological observations with the view of determining the influence of forests on climate, the statistics of forest products used as tanning materials, forest fires, insect ravages, experiments in timber planting upon the college-farm, at Lincoln, Nebr., forests in Europe, and the expensive and wasteful use of timber as a fencing material. A report has also been submitted on European schools of forestry, and forestry experiment stations. Large numbers of circulars have been issued asking for information with regard to railroad ties, and the answers returned are being examined and arranged. Circulars have also been issued inquiring into tree-planting in the prairie States, the trees selected, and the method of management.

The Hon. F. P. Baker, of Topeka, Kans., has also been employed to investigate the condition of forests in the prairie States, and in the region lying west of the Mississippi and east of the Rocky Mountains.

This preliminary report has been made, and contains valuable views upon the timber-culture act, the possibility of forest culture in the far West, with a sketch of what has been done, and some suggestions as to what should be done. Mr. Baker urges the absolute necessity of immediate action by Congress in regard to the timber-culture act, to make it effective. He proposes to visit the regions where forest fires have done so much damage and investigate the causes, and the best means of controlling them. This report will be published as a special, and laid before Congress at an early day.

ARTESIAN WELLS.

In accordance with suggestions made by the Commission employed last year to select proper locations for artesian wells, the Hon. Horace Beach and Professor White, two of those Commissioners, were employed to select what seemed to them proper places for boring the wells. They have located a well 112 miles easterly from the city of Denver, upon government land, near the station of Akron, on the Burlington and Missouri Railroad, in Colorado. A second well has been located 177 miles southeasterly from Denver, upon government land, near the line of the station of Cheyenne Mills, on the Kansas Pacific Railroad. Each location has been made with reference to the probability of supplying water to good lands, and so as to be useful, if successful, for irrigating purposes and the watering of stock. Agreements have been made for the supply of water for engine use in drilling, with the railroads alluded to, free of charge. The sites selected have been withdrawn from entry under homestead, pre-emption, and timber acts.

Contracts have been awarded to James A. Fleming & Co., of Denver, Colo., for the sum of $14,000, for drilling both wells to the depth of 2,500 feet each, if required, the contractor to furnish all the materials necessary to do the work and to pay for the labor employed. The wells are divided into sections, as follows: The first thousand feet and the balance of the 2,500 feet into 500 feet sections, the Department of Agriculture retaining the right to stop the work at any distance below 1,000 feet, and pay *pro rata* for the distance bored. The machinery has been placed on the ground, and the work of drilling has already commenced.

WOOLS AND FIBERS.

The report of Dr. McMurtrie on wools and fibers has been presented, and, in connection with a paper on the subject prepared by Miss Clara P. Ames, of Boston, and forwarded to this Department by Hon. Edward Atkinson, will soon be published. In connection with the examination of the fineness of fiber a careful study has been made of the internal structure of the fibers of pure bred and grade sheep to determine the differences arising from breeding and management, and their effect upon the strength, elasticity, and felting properties. The instruments for testing the wool fiber have been greatly improved, and the experiments entered upon by this division of the department are of great interest. It is intended that the testing of cotton fiber will be pursued in the same manner.

DEPARTMENTAL REPORTS.

In addition to the annual report of the Department for the year 1880 and 1881, of which 300,000 copies each were ordered printed, the following special and miscellaneous reports have been issued since July 1 1881:

SPECIAL REPORTS.

	No. of copies printed.
No. 34. Contagious diseases of domestic animals. 391 pp., octavo. Illustrated.	50,000
No. 37. Condition of crops, June and July, 1881. 24 pp., octavo	10,000
No. 38. Conditon of crops, August, 1881. 24 pp., octavo	10,000
No. 39. Condition of crops, September, 1881. 30 pp	10,000
No. 40. Condition and needs of spring-wheat culture in the Northwest. By C. C. Andrews. 100 pp., octavo	10,000
No. 41. Estimated production of cereals of the United States for the year 1881. 8 pp., octavo	10,000
No. 42. Report on the condition of winter grain, number and condition of farm animals, &c., April, 1882. 82 pp., octavo	10,000
No. 43. Report on the condition of winter grain, the progress of cotton and corn planting, rate of wages and labor, &c., May, 1882. 20 pp., octavo	10,000
No. 44. Report upon the acreage and condition of cotton, the condition of all cereals, and the area of spring wheat, &c., June, 1882. 14 pp., octavo	10,500
No. 45. Report upon the area and condition of corn, the condition of cotton, and of small grains, sorghum, tobacco, &c., July, 1882. 33 pp	11,000
No. 46. Report upon the condition of cotton, of spring wheat, fruits, &c.; also freight rates of transportation companies, August, 1882. 54 pp., octavo	11,000
No. 47. Climate, soil, and agricultural capabilities of South Carolina and Georgia. By J. C. Hemphill. 65 pp., 1882, octavo	10,000
No. 48. Silos and ensilage. A record of practical tests in several States and Canada, 1882. 70 pp., octavo	15,500
No. 49. Report upon the condition of corn and cotton, of potatoes, fruits, &c.; also freight rates of transportation companies, September, 1882. 48 pp., octavo	11,000
No. 50. The dissemination of Texas fever of cattle, and how to control it, 1882. 14 pp., octavo	12,000
No. 51. Report upon the yield of small grain, condition of corn, cotton, potatoes, and tobacco; also freight rates of transportation companies, October, 1882. 58 pp., octavo	12,000
No. 52. Report on yield per acre of cotton, corn, potatoes, and other field crops, with comparative product of fruits; also local freight rates of transportation companies, November, 1882	11,000

MISCELLANEOUS REPORTS.

	No. of copies printed.
Preliminary Report, Commissioner of Agriculture, 1881. 58 pp., octavo	8,000
Fertilizers: co-operative experimenting as a means of studying the effects of fertilizers and the feeding capacities of plants. By Prof. W. O. Atwater, 1882. 33 pp., octavo	1,500
Florida; its climate, soil, productions, and agricultural capabilities, 1882. 98 pp	10,000
Report on the climatic and agricultural features, and the agricultural practice and needs of the arid regions of the Pacific slope, &c., 1882. By E. W. Hilgard, T. C. Jones, and R. W. Furnace. 182 pp	2,500
Proceedings of a convention of agriculturists, held in the Department of Agriculture, January 10 to 18, 1882. 204 pp., octavo	10,000
Artesian wells upon the Great Plains: being the report of a geological commission appointed to examine a portion of the great plains east of the Rocky Mountains, and report upon the localities deemed most favorable for making experimental borings, 1882	3,500

In addition to the above, there has also been prepared the following reports, which will be published as soon as the necessary funds are available:

The meat question analyzed. By Dr. G. Sprague, Chicago, Ill.

Account of field experiments with fertilizers. By Prof. W. O. Atwater, Ph. D.

Report of the proceedings of the convention to promote the sheep and wool industry held in Philadelphia, Pa., September 22, 23, and 24, 1882.

DISBURSING OFFICE.

The following table exhibits in condensed form the appropriations made by Congress for this department, the disbursements and unexpended balances for the fiscal year ending June 30, 1882:

Title of appropriation.	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$79,500 00	$79,491 89	$8 11
Collecting statistics	10,000 00	10,000 00	....
Laboratory	6,000 00	5,811 85	188 15
Purchase and distribution of valuable seeds	80,000 00	79,991 53	8 47
Experiments in the culture of tea	10,000 00	8,743 37	1,256 63
Experimental garden	7,000 00	6,968 25	31, 75
Museum	1,000 00	1,000 00	....
Furniture, cases, and repairs	4,000 00	4,000 00	....
Library	1,000 00	973 85	26 15
Investigating the history of insects	20,000 00	19,998 94	1 06
Examination of wools and other animal fibers	5,000 00	5,000 00	....
Investigating the diseases of swine, &c	25,000 00	22,443 89	2,556 11
Reclamation of arid and waste lands	10,000 00	10,000 00	....
Report on forestry	5,000 00	4,941 00	59 00
Postage	4,000 00	4,000 00	....
Contingent expenses	10,000 00	10,000 00	....
Improvement of grounds	8,000 00	8,000 00	....
Transporting, &c., agricultural and mineral specimens from Atlanta, Ga	5,000 00	893 86	4,106 14
Purchase and distribution of seeds to overflowed districts	20,000 00	20,000 00	....
*Experiments in the manufacture of sugar	85,000 00	32,333 75	2,666 25
Building for the display of agricultural implements	10,000 00	10,000 00	....
Printing and binding	11,000 00	9,156 42	1,843 58

*This appropriation has been exhausted since the close of the last fiscal year.

Very respectfully,

GEO. B. LORING,
Commissioner of Agriculture.

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